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From the Author

OBSERVATIONS

ON THE

EXPEDIENCY AND PRACTICABILITY

OF

SIMPLIFYING AND IMPROVING

THE

MEASURES, WEIGHTS AND MONEY,

USED IN THIS COUNTRY,

WITHOUT MATERIALLY ALTERING THE

PRESENT STANDARDS.

BY

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F.R.S. &c. &c.

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PREFACE.

EARLY in the year 1831, circumstances having previously drawn my attention to the system of Measures, Weights and Money, established by law in this country, it appeared to me that they were capable of being greatly improved and simplified, without any material deviation from our present national standards, and consequently without doing violence to the habits of the people; and having reflected maturely on all the details, I embodied my ideas in the form of a small pamphlet, of which 24 copies were lithographed for private circulation, and which was publicly read to the Members of the Philosophical and Literary Institution, of Chatham and Rochester, on the 5th of July of the same year, being one of the first original Papers presented to that useful Society. Some time before this period, I had submitted my ideas in conversation to my friend Mr. Telford, the eminent Civil Engineer, who encouraged me to proceed, and gave me some useful information connected with his own profession and bearing on the subject. Of the copies lithographed in May 1831, I deposited one in the library of the above-mentioned Institution. Another was presented through my Brother Officer, Major Reid, to a similar Society at Exeter, where he was then stationed. Others were presented by me to His Royal Highness the Duke of Sussex, President of the Royal Society, and to several distinguished Individuals, chiefly Fellows of

the same Society, two of whom had been Members of the Royal Commission on Weights and Measures, appointed in 1818. My chief object in making my ideas so generally known, before I published them, which I intended to do soon afterwards, was in the hope that I might benefit in the mean time, by the observations of others upon a subject of so much practical importance.

In the month of January 1832, I had put my suggestions for the improvement and simplification of the Measures, Weights and Money of this country into the same state nearly, in which they will appear in the present work, and having written an appropriate Preface, I was about to send the whole to press; when a Review published that same month, and received from London for a public Library at this place, was put into my hands by a friend; who pointed out to me the remarkable coincidence, between several of the ideas contained in an article in that Review, on the subject of Weights and Measures, and the suggestions made in my own Paper, which he had himself read six months before to the Philosophical Society above-mentioned, of which he was the Secretary.

As the Article alluded to was stated to be a Review of three pamphlets published in Scotland, of which the first appeared in Glasgow in 1823, in reference to the Bill for ascertaining and establishing conformity of Weights and Measures, which was then under discussion; I thought it probable, that those ideas of the Reviewer, which were similar to mine, might have been suggested by the Remarks of the Author of those Pamphlets, who consequently might have anticipated me also, in my opinions; and therefore, I deemed it proper to suspend my own publication, until I had ascertained this point.

In respect to the particular observations made and improvements suggested by me at that period, which with a brief Preface was all that I at first intended to publish, these had been written solely in reference to the Reports of the Select Committees of the House of Commons of 1814 and 1821, and to the Reports of the Royal Commissioners on Weights and Measures of 1819, 1820 and 1821; which several Reports together with the Statutes of 1824 and 1825 establishing the present or Imperial system of Weights and Measures in consequence of these Reports, composed the whole of

my information upon the subject, until the perusal of the Review before alluded to, induced me to extend my inquiries, from a natural desire to ascertain, how far my own ideas might or might not have been anticipated by former writers, with whose opinions I was unacquainted, when I first took this great subject into consideration.

Accordingly having procured, not without difficulty, the Pamphlets alluded to, written by Mr. John Wilson of Thornly, and having endeavoured by every means in my power to discover the systems of former writers, who gave their attention to the very important subject of Weights and Measures, during those years, when it was the subject of general discussion, first in France, or rather in all Europe, and more recently when it was under the discussion of Parliamentary Committees, &c, in this country; but at which time, occupied by other pursuits, I did not even give it a thought; I was rather surprised, that with the exception of the decimal subdivision of the foot proposed by Professor John Playfair of Edinburgh, and the use of the cubic foot as a measure of capacity proposed by the Rev. Dr. Keith, Minister of Keith Hall and of Kinkell Aberdeenshire, in one of his many projects of improvement, none of the other very simple arrangements suggested by me appear to have occurred to any former writer, in this country, at least of any whose works I have been able to procure. But whether this had been the case or not, they must rest on their own merits and not on their originality, which is a matter of little or rather of no importance in projects applicable to the practical concerns of life.

Such being my feeling on this subject, I was rather pleased than otherwise to find, that the identical fathom proposed by me, had previously, but not to my knowledge, been proposed in the year 1670 by M. Mouton, an Ecclesiastic of Lyons, distinguished by his love of science, but particularly of Astronomy, and that ideas not dissimilar had also been thrown out by Cassini, the second of that name, in his Treatise on the magnitude and figure of the Earth, published in 1718. The object of both of these writers was to suggest a universal standard of measure, on geometrical or philosophical principles; and Mouton, in particular, whose project appears to me to have been better, than that of his more celebrated countryman, actually determined the value of his own standard in re-

ference to a number of experiments with the pendulum, tried by him, and recorded in his book; but which by the reader of the present day will be considered more curious than useful, for the minute and microscopic accuracy of measurement, afterwards deemed indispensable, was totally disregarded in his time.

In perusing the various books on this subject which I was able to procure, as one research led to another, my attention was naturally called to the investigation of the successive laws on British Weights and Measures, from the time of the Anglo-Saxons to the present day, including not only those of England and of the Legislature of the United Kingdom, but also the laws of Scotland before the Union. The great similarity between the Measures, Weights and Money of England and France, in the time of Alfred and Charlemagne, and also those of Scotland, about or soon after the same period, naturally led me retrospectively to make some inquiry into the measures and weights of the ancient Romans, from whom no doubt this similarity must originally have been derived; as well as to trace the various changes that have gradually taken place, not only in England, but in Scotland and in France; and in respect to the latter country, the whole history of the transactions preceding and connected with the introduction of the new Decimal System of Weights and Measures in 1795, of which the METRE, the ten-millionth part of the mean length of the quadrant of the terrestrial meridian, was the unit, attracted my particular attention. With this investigation the figure and dimensions of the earth are so intimately connected, that I was induced to inquire into the various attempts to determine this interesting problem, from the first rude guess work of the Ancients, and the imperfect surveys of the sixteenth and seventeenth centuries, to the more accurate and gradually improving surveys of the last and present centuries, of which the most important have been undertaken chiefly by order of the French and British Governments, and of the East India Company, with improved science, and with instruments approaching continually nearer to perfection. Finally the numerous experiments made with the pendulum, with a view to determine the force of gravity in various latitudes, and from them also the figure of the earth, by many distinguished individuals in various parts of the globe, but especially

by our own countrymen, formed a subject of inquiry so intimately connected with Measures and Weights, that I was led into this investigation also: and as I have always considered it difficult or rather impossible to form a just notion, of that which one has only read of, not seen; I have for some time past, paid considerable attention to the construction and mode of observing with the first rate instruments now used in geodesical and astronomical observations; and recently I have tried numerous experiments with pendulums of two different kinds, rather with a view to obtain just notions for my own satisfaction, and to enable me to write clearly upon the pendulum, as connected with Measures and Weights, than to enter into this inquiry, as a personal pursuit.

When I had combined all this mass of information, the collection of which had occupied a great part of my leisure time for more than two years, with my original observations and suggestions on the subject of Measures and Weights; on reperusing the whole, in its extended form, I became reluctantly convinced, that however interesting to Antiquaries or to persons fond of accurate and minute research, this larger volume would be less likely to interest the public in general, than the same suggestions supported by fewer authorities, and exhibited in a much briefer shape. I therefore condensed the voluminous materials, collected by me, into the form in which my opinions are now offered to the public, to which however I proposed to have added about a hundred pages more, to explain in a popular manner the results of the various great Surveys, and of the pendulum-experiments before alluded to, from which combined an invariable standard of lineal measure, bearing as I propose a fixed proportion to the mean length of the quadrant of the terrestrial meridian, can alone be deduced;* and in this part of my subject, I had proposed to

* The modification of our present English lineal measure suggested by me, consists in increasing the length of our present standard, a little, in order to make the new fathom the thousandth part of the mean length of the minute of the terrestrial meridian, which will increase the new foot in the like proportion.

The mean length of the said minute has been estimated as follows by different authorities, viz. by Lieutenant Colonel Lambton at 1012·547 English fathoms of the present Imperial standard; by Professor Playfair at 1012·6 fathoms nearly; by the French Government at 1012·619 English fathoms nearly (that is adopting Capt. Kater's value of the French standard); and lastly from the statement of Professor Airy of Cambridge, it is equal to 1012·715 English fathoms nearly of the Imperial standard.

As part of this book was printed, before I had seen Professor Airy's mas-

include a description of the instruments necessary for the higher branches of Surveying, as well as of the apparatus proper for experimenting with the pendulum, together with remarks upon the most approved modes of using both.

Whilst thus occupied, I saw a notice in the Newspapers, that the question of Weights and Measures was once more about to be submitted to a Select Committee of the House of Commons, in order to introduce a new Bill on the subject, moved by Lord Ebrington, with the provisions of which I am unacquainted. I therefore immediately determined to cut short my labours for the present, and to submit my suggestions for simplifying and improving our present system of Measures Weights and Money to the public at once, previously to their being discussed in Parliament, without waiting to complete those further illustrations that I had in view, which are not absolutely necessary for understanding the merits of this very important question.

Those Gentlemen, who received my first lithographed Paper in the summer of 1831, will observe that in this second Edition of my Observations on Measures and Weights, for so it may justly be styled, I have introduced nothing that differs from my former views of the same subject, excepting that I have made a very minute alteration in the value of the Avoirdupois pound, in order that the new cubic foot of distilled water may possess the advantage of weighing an integral number of pounds. I have also retained the

terly article on the figure of the earth in the Encyclopædia Metropolitana, I had previously adopted Professor Playfair's proportion, in my calculations, in Articles 39, 61, 118, &c, estimating the proportion which the new foot ought to bear to the present standard foot as 1012·6 to 1000·0; but as Professor Airy had the advantage of comparing with former Surveys the results of new ones not finished or not published, when the other wrote, it may be presumed that his proportion is the most accurate.

Should my suggestion as to the modification of our present measure be adopted, it would be proper to refer the matter to a Committee of Men of Science, who may probably make a still nearer approximation to the true mean length of the minute of the terrestrial meridian, than any of the preceding statements, for new Trigonometrical Surveys of importance are in progress, and more are likely to be undertaken, each of which will add to the data for forming a correct estimate.

Professor Airy's Treatise, which I have just quoted, contains a most valuable abstract of the results of the great Surveys, and of the most important pendulum experiments, so far as they had been published in 1830. More detailed information is to be found in the Transactions of Scientific Bodies, or other books to which he refers. Subsequent experiments on the pendulum, of great interest, by Mr. Baily and Capt. H. Foster of the Royal Navy, will be found in the Transactions of the Royal and of the Astronomical Societies.

yard, which I formerly proposed to abolish, but it is to be confined to cloth measure exclusively: and I have given up my original idea of a new ounce, of fourteen to the pound, instead of which I now propose to subdivide the new pound into ten equal parts, for the common retail purposes of commerce.

I before remarked, that it was with some reluctance that I abandoned the historical and critical notices, which I had made of the progressive changes of measures and weights, and of the ideas of former writers on the subject. But I also stated, that my own observations had been previously deduced from reflection upon the existing system as by law established, without any knowledge whatever at that time either of the old English statutes, or of the books alluded to. And my regret in being obliged to leave out those details, after having employed considerable labour in compiling and arranging them, is diminished by the consideration, that the public will most probably judge of the expediency of the improvements suggested by me, in comparison with the present system only, and without reference to the obscure records of the dark ages, and probably also without reference to the projects of former writers on the same subject, the most original of which nearly resemble in principle the decimal system of the French, which has not been approved as a model for imitation in this country: and which appears to me to have been very properly rejected, inasmuch as I conceive that the strongest objections may be urged against a total change in such matters.*

* The Reverend Dr. George Skene Keith, who continued his zealous researches into this subject for more than thirty years, first proposed that the length of the seconds' pendulum at London, should be made the unit of all measures of length, surface, capacity and weight, and that all its multiples and parts should be strictly decimal, in the same manner as the metre was afterwards made the general unit for the new decimal system of measures and weights adopted in France. I say "afterwards," because Dr. Keith's first pamphlet, which was the most original of his various projects, appeared in 1791, and was evidently written without any knowledge or anticipation of what was likely to be done by the French. In this pamphlet he further suggested that his new weights, and a new coinage, also proposed by him, should be identical, each coin being distinguished by weight alone.

Despairing of seeing this great change carried into effect, he proposed various other projects, of which some were only modifications of existing measures. In one of these he proposed that 10 cubic feet should be the quarter of corn, to be divided into five firlots, and that the cubic foot should be used as a measure, to be called the half firlot, or cube, in addition to the bushel. This suggestion, in which he anticipated one of my ideas, would not have been an improvement, unless he had like me entirely rejected the

I cannot however pass over the labours of former writers, without acknowledging in particular the benefit, which I derived whilst investigating the historical part of my subject, from a book printed at Washington in 1821, as an official Report upon Weights and Measures, made by a distinguished American Statesman, Mr. John Quincy Adams, to the Senate of the United States, of which he was afterwards the President. This author has thrown more light into the history of our old English Weights and Measures, than all former writers on the same subject, and his views of historical facts, even when occasionally in opposition to the Reports of our own Parliamentary Committees, appear to me to be the most correct. For my own part, I confess, that I do not think, I could have seen my way

bushel. On the contrary it would have been injurious, by introducing additional measures of capacity in a system, where there were already too many.

Professor John Playfair considered the new French decimal system, of which the metre was the unit, as the most perfect that could be imagined; but hopeless of seeing it adopted in this country, he condescended like Dr. Keith to propose certain modifications of existing standards, which were published as an Appendix to a Report of a Committee of the Highland Society upon Weights and Measures in 1812. He had previously expressed his high admiration of the French decimal system, in a very able Article in the Edinburgh Review for 1807.

Mr. Robert Wallace, Andersonian Professor of Mathematics at Glasgow, wrote several pamphlets on this subject, in the first of which, published in 1822, he recommended a system, similar to that of Dr. Keith and of the French, in which he differed very little from either; except in recommending the use of the Equatorial pendulum as the unit of all measures and weights, in preference to the London pendulum, and to the French metre. He also proposed several modifications of this his first project, as well as of existing measures, provided that entire change could not be effected.

Mr. John Wilson of Thornly, then one of the Directors of the Chamber of Commerce of the city of Glasgow, in his pamphlet of 1823, quoted in the Review before alluded to, proposed nothing original, but merely recommended some little changes in the details of the Bill for uniformity of Weights and Measures of 1824, whilst in progress, on the authority of former writers. The same remark applies to two other pamphlets, both anonymous, but ascribed to him by the same Reviewer, the first of which, published in 1829, was merely a comparison of the old measures and weights of Scotland with the imperial standards, &c. The second consisted of Notes on the Stirling jug or standard pint of old Scottish measure, from which all the other legal measures of capacity in Scotland were derived.

It is remarkable that the subject of Weights and Measures appears always to have attracted more notice in Scotland, and to have been investigated by more writers there, than in any other part of the United Kingdom. Besides the foregoing authors, Lord Swinton's work, published at a still earlier period, in 1779, and entitled "A Proposal for uniformity of Weights and "Measures in Scotland by execution of the laws now in force," is very creditable to the author, as well as extremely useful; for it explains the whole of the local weights and measures of Scotland, of that day, as compared with the then English standards, which he proposed to inforce, agreeably to one of the provisions of the Act of Union.

into the history of English Weights and Measures in the feudal ages, without his guidance. At the same time, I do not agree in all the opinions deduced by him from his able and laborious researches. For example, he speaks with approbation of the system, which prevailed in England, about and soon after the period of the Norman conquest, of having two gallons and two pounds, namely a wine gallon bearing to the corn gallon the same proportion nearly, which the money pound bore to the mercantile pound of the same period.* So far from there being any advantage in having two gallons, it has been generally allowed, that the abolition of the wine gallon and of the corn gallon, and also of the beer gallon, as separate measures, was one of the most judicious clauses in the Statutes of 1824 and 1825, and it appears to me a matter of regret, that the legislature of that day, when they established one gallon instead of three, did not also establish one pound, instead of two. I also differ from him in the admiration which he expresses for the new French decimal system of weights and measures, established in 1795. Notwithstanding the splendid talents and deservedly high reputation of the eminent men, with whom it originated, and the encomiums with which it has been applauded by some distinguished individuals in other countries, it

* It is declared in Magna Charta, that "one measure of wine shall be "through our realm, and one measure of ale, and one measure of corn, that "is to say the quarter of London; and one breadth of dyed cloth, Russetts "and Haberjects, that is to say two yards within the lists. And it shall be "of weights as it is of measures." (See in the Statutes of the Realm, vol. I., page 117, the 25th chapter or article of the Act entitled, "The Great Charter "of the liberties of England, and of the liberties of the Forest, confirmed by "King Edward, in the twenty-fifth year of his reign. A.D. 1297.")

It has generally been supposed, that this article of Magna Charta was intended to establish perfect identity between the wine measure, ale measure and corn measure, of that period; but the words may be understood two ways, and Mr. Adams has proved at least to my satisfaction, contrary to the more generally received opinion, that there must have been two different gallons, a wine gallon and a corn gallon in England, at that time. He has not asserted, nor have I found any thing in the course of my own researches to induce me to suppose, that there was also an ale gallon, until several centuries afterwards. From our ancient laws it appears, that the old English wine gallon was evidently an eight-pound measure of wine, and in like manner, the corn gallon may have been, and in all probability was, as Mr. Adams states, intended for an eight-pound measure of wheat of average quality. But I cannot agree with him in his approbation of the system of having two gallons and two pounds. So far as regards the former, every commodity differing in specific gravity from wheat of average quality, ought by the same rule, to have had its own separate gallon also, which would have led to endless confusion; and in respect to the proportion between the two gallons, and that between the two pounds being so nearly equal, I am not inclined, like Mr. Adams, to ascribe this coincidence to design, but to accident.

appears to me that it was far from being a judicious system. The great and fundamental error was, that instead of reform, this new system introduced revolution, and not merely revolution, but the complete annihilation, of all the existing measures and weights of France without exception; thus involving not rational improvement, but the absolute destruction of all former habits and notions of practical men relating to such matters, without substituting in their place any thing, that could be understood by the mass of the people. Had it been applied to a nation of savages, whom it was suddenly proposed to civilize, and who having never had any previous standards of weights and measures of their own, had no habits to lay aside, and no reminiscences to get rid of, it would have been an excellent system; but however perfect in detail, and well combined in all its parts, it appears to me that nothing could be worse suited to all the practical purposes of life, in a civilized country like France, in which the people cannot be compelled to change their old habits all at once, in the same manner as a Regiment may be made to change its uniform.

For example, to consider the practical effects of this system, all the French Mariner's ideas of latitude and longitude, and of distance on the ocean, were completely confounded, by the change of DEGREES and MINUTES, MARITIME MILES and LEAGUES, into the incommensurate and to him almost incomprehensible GRADES, KILOMETRES and MYRIAMETRES of the new metrology. All his former nautical charts and astronomical tables became useless: and his notions, not only of space but even of time were confounded; for a quarter past two o'clock in the afternoon became 94 minutes past ten: six o'clock in the evening was converted into half-past two; midnight became five o'clock; and three o'clock in the morning was changed into a quarter past six of the new decimal time.* The French Cannoneer, who manned his battering gun, was told that the balls he used were no longer 24 POUND SHOT, but weighed 11 KILOGRAMMES, 7 HECTOGRAMMES, and 5 DECAGRAMMES.

* Though generally arranged on scientific principles, some parts of the new French system were very crudely concocted. The new calendar for example was extremely ill judged, especially the epithetical names of the months, *snowy*, *rainy*, *flowery*, &c, &c, which one could scarcely have supposed that any people but the Esquimaux, who knew no climate but their own, would have consented to adopt.

The French Builder or Carpenter, who had been habituated from his boyhood, to measure and estimate the details of his work by the FOOT, INCH and LINE, was directed to use the DECIMETRE, CENTIMETRE and MILLIMETRE, the first less than four French inches, the second less than half an inch, and the third so very minute, as to be quite unsuited to the mechanical arts.* But I abstain from enlarging further, upon the strong objections against such an overwhelming change in the measures and weights of any country, to inforce which exceeded the power even of the formidable Revolutionary Government of France, armed with all the terrors of the ancient proscriptions. I have already said enough, to enable the intelligent reader to see the cause, of such a system having been, as it were unanimously, rejected by the whole population of France, in all their private business. And although employed in large contracts or commercial dealings, in which the Government was a party, the new decimal measures and time were not used, because in fact they could not be used, even in the French Navy, nor were the new weights used even in the French Artillery, in which the 24 pounder still remained a 24 pounder, in contempt of the unintelligible fractional new weight, into which it ought to have been changed. So complete was the failure of this new system, that in the short space of five years, after Professor Playfair had recommended it to his own countrymen with the emphatic quotation, "*Fas est et ab hoste doceri,*" in reference to the vigorous war in which France and Britain were then engaged; this most inconvenient and perplexing system was virtually abolished in the former country, by the Edict authorizing what was then called *Usual Measure*, which restored the names and former proportions of all the old measures and weights of France, and in which the difference of quantity between the respective standards of each sort, the old and the usual, was not so great as to cause any confusion or perplexity, to those who had been accustomed to the former in early life. Thus when it had been found, after a trial of only seventeen years, that the great mass of the population of France could not or would not use the new

* A vigorous Carpenter would demolish 5 or 6 millimetres of the hardest wood with one sweep of his jack plane. The parts of a scale divided into single millimetres, could not be distinguished clearly without the aid of a magnifying glass.

decimal system of measures, and the Government was unwilling to restore the old; a sort of compromise took place, by the introduction of a third system, namely the usual system, just alluded to, which is a compound of the two former.

Although the reasons, which induce any person to write on a particular subject, may perhaps be a matter of indifference to the public in general, I may be permitted to explain the peculiar circumstances, which led me first to turn my mind to this subject, some years ago, at a time when I heard no complaints from others, and when I believe that well-educated men generally had a favourable opinion of the existing system. These circumstances originated in my professional pursuits, which alone have caused me to appear before the public as an Author; for none of my successive publications have ever diverged into general Literature, or treated of other than Military topics, or subjects connected with my official duties. Some years ago, an Order having been given by his Grace the Duke of Wellington, then Master-General of the Ordnance, that the Junior Officers of the Royal Engineers should be instructed in Practical Architecture, at the Establishment under my direction, and a very zealous, intelligent and well qualified person, having been appointed to act as Teacher or Professor of this branch; I was induced, from having the general superintendence of all the duties of the Institution, to inquire into the system of measuring and estimating Artificers' and Labourers' work, as applied to Buildings, &c, and circumstances having never led me to enter into such details before, except in a very cursory manner; I was surprised to find, in spite of the very great ingenuity displayed by men of the Building Profession, in bringing their system of measuring and estimating to perfection, that it was embarrassed by a number of unnecessary difficulties, arising from the complex nature of the measures used in this country, which causes not only a great deal of trouble, that might be avoided, but often leads to pernicious errors in calculation, the inevitable result of such a system. Soon afterwards I had occasion to estimate by calculation the quantity and weight of some woodwork, intended for field platforms and powder magazines, previously to its being used; and I found that the same cause rendered these calculations, simple as they are in principle, exceedingly

troublesome. Subsequently, in the course of my researches into the former subject of Practical Architecture, having occasion to compare the strength of natural and artificial water cements, by adding weights gradually, until either the joints or the bricks, of masses of brickwork cemented by both of these kinds of cement, broke down, I found the standard weights in common use, so exceedingly inconvenient and perplexing, that after a short time, as minute accuracy was not my object, and as considerable weights were required in each experiment, I provided a great number of 24 pound shot, which I used by putting them into a cask on the scale board, until by degrees fracture was produced; and thus I concluded my experiments in a more simple and satisfactory manner, than I had found practicable with the common standard weights.*

To persons who have been familiar with the use of existing weights and measures from early youth, before their reasoning faculties were developed, these difficulties are not apparent. They have never known a simpler system, and the calculation of complex dimensions, like expertness in bodily exercises, becomes comparatively easy from habit. Gentlemen in private life, and even men of science, can have still fewer opportunities of judging by their own experience; but if they would take the trouble to examine into the mode of preparing the accounts of a Builder, who is to be paid by measurement, they being entirely new to the subject as I was, they would see the evils of the existing system in the strongest possible light.

The advantages of a more simple system of weights and measures, such as I am about to propose, will not be disputed. Every one will admit its immense superiority over the complex system, which it is intended to supersede. But it has been urged, that old habits and prejudices are not to be shaken off so easily, as I may suppose, and that the feelings of the people throughout the British Empire will be against it. I am sensible of the difficulties, which would have opposed such a project with insurmountable force in former times; but in the present age, all those peculiar prejudices, that could have been wounded by this improvement are extinct, or

* I have alluded particularly to the two last subjects, namely the calculations respecting woodwork, and the experiments for breaking the cement joints of those brick masses, in Article 228, Page 128 of this Treatise.

nearly so. The greater part of the youth of both sexes, even of the labouring classes, can not only read and write, but understand the most useful rules of Arithmetic. In almost every large town, a Philosophical and Literary Institution has been formed, where the middling classes of society devote to intellectual pursuits, that spare time, for the employment of which they formerly had no resource except in the Tavern: and in every great manufacturing city a Mechanics' Institute has been established, in which those intelligent men, who pass their days in useful labour, often of a nature not to be executed without great ingenuity, employ their evenings in the improvement of their minds: and whatever disputes may occasionally occur between men of this class and their employers, as to the rate of wages, and other points, in which their interests may appear to be opposed, I feel confident, that there will be only one opinion as to the advantages, which both will derive from a simpler system of measures and weights, which no men in this country are more capable of appreciating, than those who use them continually in all their mutual transactions. Besides which, so far as regards the internal commerce of the country generally, and without reference to the mechanical arts exclusively, the means of communication from one part of the British islands to another, have been recently so much increased and facilitated by the multiplication of canals, superior roads, railways, and steam vessels; that the improvements now suggested, which in former times, when there was little intercourse between distant parts of the United Kingdom, would comparatively have been of less importance, may now be considered, not a matter of mere expediency, but of absolute necessity. The age of gas lights, and of steam, is not that, in which one ought to despair, even of effecting a very considerable change in measures and weights, if a new system were absolutely necessary. But the chief characteristic, and if I judge rightly, the chief recommendation of my plan, is that there is no part of it, of constant application to the daily business of life, that is entirely new. The principal existing standards of our measures, weights and money, namely the English foot, the quart of liquor, the quarter of corn, the avoirdupois pound weight, and the pound sterling, have been adhered to, with so very little variation, as can neither offend old habits, nor create inconvenience to any

class of the community; at the same time that by the simplification of their parts and multiples, all our standards will be freed from the inconsistencies and complexity, with which they have been embarrassed since the earliest periods of our history.

I may be permitted to conclude by stating, that if the suggestions contained in the following pages should be adopted, the fine idea generally supposed to have been intended in Magna Charta, and most clearly and unequivocally expressed in one of our ancient laws of subsequent date, but which has never yet been realized in this country, will literally be accomplished; namely that THERE SHALL BE ONLY ONE MEASURE, AND ONE WEIGHT, THROUGHOUT ALL THE LAND.*

C. W. P.

Establishment for Field Instruction,
Royal Engineer Department, Chatham.
May the 3rd, 1834.

* See the tenth Chapter of an Act of the 27th of Edward the Third, Statute ii, entitled *Ordinacio Stapularum*, in the Statutes of the Realm, vol. I, page 337, of which the following is an extract.

"ITEM, because we have perceived that some merchants do buy avoir de "pois (*that is weighable commodities*) wools and other merchandises, by one "weight and sell by another, and make also deceitful draughts upon the weight, "and also use false measures and yards, in great deceit of us and of all the "commons, we will and establish, THAT ONE WEIGHT, ONE MEASURE, AND "ONE YARD, BE THROUGH ALL THE LAND, &c."

The proposition for making the cubic foot the sole unit of measures of capacity as well of solidity, which as it were identifies measures of capacity with lineal measure, has enabled me to express this fine idea more briefly than in the original, in which the word MEASURE applies to the former, and YARD to the latter.

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OBSERVATIONS,

&c.

PRELIMINARY REMARKS.

(1) THE Royal Commissioners, appointed in the year 1818, to inquire into the Weights and Measures of this country, who were composed of the then President of the Royal Society, and of a selection of some of the most distinguished members of that body, having laid down rules for determining the Standard Weights and Measures to be used; and the standards recommended by them having been approved and ordered to be adopted throughout the British dominions, by Acts of Parliament passed in 1824 and 1825; it may perhaps seem presumptuous to make any further suggestion on this head; but as the subject is of great public importance, I propose respectfully to state, in what manner it appears to me, that the Measures and Weights of this country may be greatly simplified and improved, without deviating materially from the present standards, either of measure or of weight.

(2) I agree fully in the opinion advanced by those Commissioners, and afterwards sanctioned by Parliament, that a total and radical change of all our measures and weights, such as was effected by the French in 1795, when they introduced a decimal system, not based upon their old measures and weights, but altogether differing from them in every respect, would not have been advisable in this country. Indeed it was found so inconvenient in France, that the Government eventually were obliged to relax, by permitting a modified system of measures and weights, curiously compounded out of the new and old, in which the old nomenclature was applied to aliquot parts, or integral multiples of the new decimal standards. Hence there are no less than three kinds of measures, that may be referred to in France.

(3) First, the old French measures of *Toise, Foot, Inch,* and *Line;* the toise being equal to 6 feet, the foot equal to 12 inches, and the inch equal to 12 lines; which measure of course applies to all statements of measurements contained in French books published previously to the above-mentioned year.

Secondly, the new decimal measures of *Metre, Decimetre, Centimetre, Millimetre,* &c. none of which are exact multiples or parts of the former; and

Thirdly, the old terms revived, but with new values, deduced from the decimal system, and with the epithet *usual* attached to them; *viz.* the *usual Toise* equal to 2 metres of the decimal system, the *usual Foot* equal to one-third of the metre, the *usual Inch* equal to one thirty-sixth part of the metre, and so on.

In like manner, so far as regards weights, the term *usual Pound* has been applied not to the old French pound *(Livre de Marc),* but to one half of the new decimal weight, the *Kilogramme,* which was not an integral, but a fractional multiple of the former standard weight of France.*

In like manner also, so far as regards measures of capacity, the term *usual Boisseau* has been applied, not to the old French boisseau, but to one-eighth part of the new decimal measure the *Hectolitre,* which was not an integral multiple of the former standard measure of capacity of France.

(4) Seeing therefore the embarrassment, that might reasonably have been expected, and which in France has been the actual consequence of a complete departure from all the old standards of measures and weights, I admit that the Royal Commissioners in this country acted more judiciously in recommending, and Parliament in adopting, standards, either identically the same with, or nearly approximating to, the old measures and weights of England. But at the time that those standards were determined, with all the accuracy of which such matters are susceptible; and whilst one gallon or standard of measures of capacity was judiciously substituted in place of three, nothing was done in respect to other measures, and no suggestions were offered for simplifying the multiplicity of weights, by which the internal commerce of this country is embarrassed. As some further improvement is therefore desirable, I shall take the

* The new system of usual measure, based upon the metrical system but with the old nomenclature, was first permitted by Napoleon in France in 1812, and afterwards inforced by a Royal Decree of Louis the Eighteenth in 1816, but in both cases for retail dealings only.

subject into consideration, commencing with the present measures of length, surface, and solidity, used in this country, and proceeding afterwards to those of capacity, and of weight, and lastly to our national money; for a simplification of our measures and weights alone, although of very great advantage, must be considered an imperfect arrangement, unless the means of fixing the pecuniary value of any commodity, that is to be measured, or weighed, be also rendered equally simple.

OF THE PRESENT STATUTE ENGLISH LINEAL MEASURE, COMMONLY TERMED LONG MEASURE.

(5) *The Long Measure usually stated in books is as follows.*

3 Barleycorns .....1 Inch.
12 Inches .....1 Foot.
3 Feet .....1 Yard.
5½ Yards .....1 Rod, Pole, or Perch.
40 Rods, or 220 Yards .....1 Furlong.
8 Furlongs, or 1760 Yards ..1 Mile.
69 1/15 Statute Miles, nearly ....1 Degree.

Of these measures, the foot and inch apply to architectural and mechanical measurements exclusively, whilst the mile, furlong, rod, and yard, apply to itinerary measurements only.

Besides the above, the following lineal measures are used for special purposes, *viz.*

For measuring the height of Horses and Cattle.

4 Inches.....1 Hand.

For Land Surveying.

100 Links .....1 Chain of 22 Yards.
10 Chains .....1 Furlong.
80 Chains .....1 Mile.

For Nautical Purposes.

6 Feet .....1 Fathom.
1012½ Fathoms, nearly .....1 Nautical Mile.
3 Nautical Miles .....1 League.
60 Nautical Miles, or 20 Leagues ..1 Degree.

In considering the above, it appears in the first place highly objectionable, that there should be two miles, one of 1760 yards, and the other equal to about 1012½ fathoms, or to 2025 yards nearly. The abolition of one of these two

miles undoubtedly appears to be a most desirable object; and when we consider that the Nautical or Geographical mile is used by all the maritime nations of the world, as well as by ourselves, for measuring the course of ships on the ocean, and has, I believe, already been adopted as their only mile by some of the Italian States, it may be allowed, that this mile ought decidedly to have the preference over the common English mile; especially as the former is precisely one sixtieth part, or one minute, of the mean length of the degree of the terrestrial meridian, and may be assumed also as the minute of the degree of any great circle on the earth's surface, of which the common English mile is a very awkward fraction. It may next be observed, that to use two measures so nearly approaching to each other as the yard and the fathom is inexpedient, for in such matters a multiplicity of denominations is always to a certain degree embarrassing. I would therefore beg leave to suggest, that one only of these two shall be retained for the measurement of distances. But in adopting the nautical mile, as the only mile, it is no less desirable that the fathom or the yard, whichever of these two be retained, should be converted into a simple and convenient fraction or aliquot part of the mile. Now the value of the nautical mile being, as was before observed, very nearly equal to 1012½ fathoms of our present standard measure, I propose that a new fathom, also subdivided into 6 feet, as at present, shall be adopted, of such length, that 1000 of these fathoms shall be exactly equal to one nautical mile. This suggestion offers the simplest and most convenient of all possible proportions, between the mile and the next lower denomination of lineal measure; which fortunate coincidence, combined also with the circumstance of the fathom being the most convenient measure for Naval soundings, will render it expedient to retain that measure in preference to the yard. These arrangements will render a small diminution in the length of the surveying chain necessary, which will tend to simplify itinerary measurements. I also beg leave further to suggest the abolition of the rod of 5½ yards, but whilst I retain the foot, a little increased above its present standard, in order to suit the new fathom, I propose to subdivide this new foot into 100 equal parts, 10 of which shall be called a digit.

(6) On these principles the following Table has been constructed, which will afterwards be considered somewhat

more in detail, than appeared necessary in stating the subject.

PROPOSED NEW TABLE OF LINEAL MEASURE.

For Architectural and Mechanical Purposes.

10 Parts .....1 Digit.
10 Digits, or 100 Parts.....1 Foot.

For Itinerary and Nautical Purposes.

10 tenth parts or Links.....1 Fathom of 6 feet.
1000 Fathoms .....1 Mile.
60 Miles .....1 Degree.

For Land Surveying.

100 Links .....1 Chain of 10 fathoms.
100 Chains .....1 Mile.

(7) There cannot be a doubt of the superior simplicity of the new system of lineal measure proposed. The only objection that can be stated, is the possibility of its creating inconvenience or confusion by its novelty; and this remains to be discussed.

In the first place, so far as regards the change in the length of the foot, the increase proposed is so exceedingly moderate, that it cannot possibly disturb the ideas of men accustomed to our existing measures; for the proportion of the new to the old being as 1012½ to 1000 nearly, or as 81 to 80, it follows, that 6 feet 9 inches, or 6 feet and nine-twelfth parts of a foot of our present measure, would become 6 feet and 8 twelfth parts of a foot of the new. This difference is so trifling that it never could be judged of by the eye, without having two standards of both measures to compare together in the same view. And in reference to Architectural and Mechanical Drawings, as all the parts are in proportion, the plates of old books, constructed according to the smaller foot, would be equally useful and valuable if read off by the new measure; for in Architecture it is the general effect of the several parts, not the absolute dimension to a hair's breadth of any, that constitutes the merit either of a design or of a building already executed. To subvert the old measures of a country altogether, as the French did when they established the metre, decimetre, centimetre, and millimetre, in place of their ancient toise, foot, inch, and line, could not but create a total revolution, and consequently extreme confusion, in the habits of practical men; but to give so very small an increment as one part in eighty to the present standard English foot, in order

to make it a convenient decimal fraction of the mean nautical mile, and consequently of the minute of the degree of the terrestrial meridian, is a change so little embarrassing, that it sinks into utter insignificance, when compared with the important advantages to which it leads.

(8) The abolition of the English mile will lead to new measurements of our high roads, and to new positions of our mile stones: and will render new editions of all our British road books necessary. These changes will be attended with very little inconvenience. The former will give employment for a time to a number of Surveyors and their assistants; the latter for a much shorter time, and to a much smaller number of Printers.

(9) I propose to abolish the term league, which has of late become almost obsolete, even amongst sea-faring men; and on the same principle of the inexpediency of using many denominations, when fewer will suffice, it appears to me, that the term furlong ought also to be abolished. Indeed so natural is the disposition of mankind to simplify, that in many parts of England, this term is never used at all, and if it were not taught to youth in books of Arithmetic, it would soon become obsolete. For common purposes, therefore, in which great accuracy is not required, distances less than a mile are best expressed in halves and quarters, according to the universal custom of the country, which also is to call one furlong "half a quarter of a mile," and to express such a distance as 7 furlongs, by "rather more than 3 quarters of a mile."

(10) For all purposes in which greater accuracy is desired, the present custom is to state distances under, and even sometimes those exceeding a statute mile, in yards exclusively; as is done by military men in expressing the distance of a battery, or the range of a piece of ordnance. To those who have been accustomed to estimate such distances by the eye, the rejection of the old yard, and the adoption of the new fathom instead of it, will occasion little embarrassment; nothing being more simple, than the reduction of such a distance, as 1700 yards into 850 fathoms, which may be done mentally, without regarding the trifling difference of one-eightieth part in excess, of the new over the old measure.

(11) The chain of the Land Surveyors, as applied to our present measures, affords not only the most useful and ingenious method of measuring land for agricultural purposes, but also of measuring and laying down the itinerary

distances, which form the subject of road books. In establishing the nautical mile of our distinguished Navigators as the mile of Landsmen also, it appeared proper to alter the length of the chain from 22 yards, to some aliquot part of the nautical mile. By adopting 10 fathoms of the new measure as the precise length of the new chain, which is also to be subdivided into 100 links like the former, the link will become exactly the tenth part of the fathom. Hence all distances that are to be expressed in fathoms, but which do not involve an integral number of fathoms, may be most conveniently stated in fathoms and tenths. For example, I would state the distance of a battery as being equal to 1057·9 fathoms, or to 1057 fathoms 9 links, in preference to stating it as 1057 fathoms, 5 feet, 4 digits; and as all distances for itinerary purposes are best measured in chains and links, the surveyor will thus be enabled to state them in aliquot parts of the same instrument, with which he measures them.

(12) A very great disadvantage, attending our present lineal measure, will be removed by adopting the new system proposed. When we hear such a distance as 47,565 yards mentioned, it is quite impossible to form any idea, how many English miles it is equal to, without performing a very troublesome calculation in Arithmetical Reduction. In like manner, no one knows how many yards are contained in 79 miles and 3 quarters, and very few persons could even guess at the probable number, without putting pencil to paper, and multiplying the mixed number $79\frac{3}{4}$ into the number 1760, which is a very troublesome process.

By the new system suggested, this embarrassing uncertainty, as to the comparative value of the greater and lesser denominations of itinerary measure, will be completely done away, as the value in miles of a given number of fathoms will be known at once, without the necessity of calculation, and without even an effort of the mind. Thus, for example, 83,760 fathoms will be known as being equal to 83 miles and 760 fathoms, or a very little more than 83 miles and 3 quarters: and, vice versa, 157 miles and a half will, in like manner be known, as it were by intuition, to be 157,500 fathoms. Every one must admit the vast importance of this improvement.

(13) According to the present custom of this country, as before mentioned, the foot is used exclusively for all architectural and mechanical measurements, which however are afterwards reduced by calculation to a much more

complex form; whilst all itinerary distances are stated in some higher denomination, such as yards, rods, furlongs, or miles; and I believe that in some districts fathoms are also used, although this is less common. It will have been observed (in Article 6) that I propose to retain the same principle, which is a very judicious one, but with the advantage of greater simplicity, by using the foot exclusively as the unit for all measurements of the former kind, and the fathom for the latter.

(14) The rod of 5½ yards is, of all our English measures, the most objectionable, it being useless as a lineal measure; and indeed as such nearly obsolete, it having been superseded by the Surveyor's chain. Unfortunately it has been retained as an element of all our superficial measures, applied to which it causes a vast deal of unnecessary trouble for no purpose upon earth. Such a measure as the rod, which was originally a long pole cut in a wood, and which is incommensurate with the two next lower denominations the yard and the foot, and a most awkward multiple of the inch, is only worthy of those days of feudal ignorance, in which the standard of English lineal measure was referred to the average length of a barleycorn, and the standard of weight to the average weight of a dry grain of wheat, from the middle of the ear.*

(15) In the table of our present long measure before stated, I inserted the barleycorn, merely for the purpose of pointing out the absurdity of the practice of almost all our Elementary Writers on Arithmetic, in retaining that obsolete subdivision of the inch, in teaching which to their readers, as well as in teaching the Flemish ell, and the French ell, as parts of English cloth measure, they have been teaching superfluity or error. If the third part of an inch were a measure in common use, it would be the most inconvenient of all possible subdivisions of that dimension, but as it is never used at all, it is perfectly ridiculous to insert it in a table of English measures; and yet I have never seen it omitted in any, excepting in those which are given in the Almanac of the Society for the diffusion of Useful Knowledge.

* Dr. Kelly states, in his Universal Cambist, that besides the statute pole of 5½ yards or 16½ feet, there is the Woodland pole of 18 feet, the rope of 20 feet, the pole plantation measure of 21 feet, the Cheshire pole of 24 feet, and the Sherwood pole of 25 feet. So far as regards the practice of the most eminent Architects, Builders and Surveyors in this country, the pole is entirely obsolete as a measure of length or distance, for they never use it in actual measurements, only in calculation.

(16) For architectural purposes, the present English foot is always subdivided into 96 equal parts, namely, into inches and eighths, and this system is universally adopted by Architects and Builders, and by all the Mechanics employed under their superintendence, who lay out the minuter parts of their work by a 2 feet rule of 24 inches, subdivided in the above manner. But when they come to measure their work, in order to find quantity and value, they are obliged to use the duodecimal instead of the octaval divisions of the inch. Now to plan and mark out work by inches and eighths, and afterwards to estimate the value of the same by inches and twelfths, is evidently an inconsistency, which might be got rid of to a certain degree, by subdividing the English foot into inches and twelfths, like the old French foot. But there is an objection to this arrangement, inasmuch as the English foot is so much smaller than the French, that the duodecimal divisions of the English inch would be too minute, and as it were crowded together, and therefore not so clear and distinct to the eye, as is desirable. Hence although the superior 2 feet English rules, made of ivory for the use of Architects, &c. have their inches on one side usually divided into eighths, and on the other side into twelfth parts; the latter are never used in practice, and by inspecting both, it will be seen, that they are much less clear than the former. On another side of the same scales, it is also common to divide the inches into tenth parts, and this system of dividing the inch has been exclusively adopted by Gagers or Revenue Officers, in their calculations; although in their measurements, they do not use the common Mechanic's 2 feet rule, but a much longer sliding rule, by which they not only measure, but occasionally perform their calculations; as is also done by Timber-measurers, who use a sliding rule similar in principle, but graduated differently, so as to suit their own business. But it would be superfluous to enlarge further upon sliding rules of any description, as these form no part of the common measures of the country, to which our present subject is confined.

(17) Besides the three modes of subdividing the English foot that have been stated, namely, into inches and eighths for laying out Artificers' work, into inches and tenths for the gaging of casks, &c., and into inches and twelfths for calculating the measurements of Artificers' work; it is proper to observe, that the system of subdividing the foot into 100 equal parts, which has been recom-

mended by me in preference to any of the above, is not altogether a novelty in this country; it having been already adopted by all our Civil Engineers, in taking levels, for the purpose of laying out Canals, Railways, or Roads. In planning any portion of a road in particular, it is absolutely necessary to determine the proportional slope, which can only be done, by dividing some measured distance by the difference of level between its two extreme points. If for example we suppose the difference of level between any two points, that are 377 feet 9 inches distant from each other, to be exactly 15 feet $8\frac{7}{8}$ inches, before we can fix any proportion between these two dimensions, they must both be reduced to eighths of an inch, by which we obtain the two numbers 36264 and 1511, and the former being divided by the latter, yields 1 foot in 24 as the slope due to the above measurements. Hence every such question, if stated in feet and inches, involves two operations in Arithmetical Reduction, and one in Long Division. By rejecting the inch altogether, and adopting the decimal subdivisions of the foot, these calculations are of course very much simplified, since the distance may be divided by the height at once; and thus the troublesome process of the two arithmetical reductions is saved. The decimal subdivisions of the foot tend no less to simplify and abreviate all calculations dependent upon the measurement of Artificers' work; as will be explained in some of the following articles, and this important advantage is the chief reason, that induced me to recommend the abolition of the inch and its parts.

(18) If the subdivisions of the proposed new foot, thus divided into hundredth parts, be compared with those of the present English foot, as divided into inches and eighths, they will be found so very nearly equal, that the former will be almost as distinct and clear to the eye as the latter, from which they only differ by about one thirty-sixth part in defect.

(19) It will have been observed, that in the new Table of lineal measure before given (Article 6), I have omitted the hand. The abolition of this measure will simplify, to a certain degree, as it is certainly best to measure the height of horses, and of all other animals, in feet and parts of a foot, according to the more accurate practice of the scientific Zoologists of this country, who never make use of the hand of the horse dealers.

(20) We will next proceed to Cloth Measure.

OF THE PRESENT ENGLISH CLOTH MEASURE.

4 Nails (of 2¼ inches each) .....1 Quarter of a Yard.
3 Quarters .....1 Flemish Ell.
4 Quarters .....1 Yard.
5 Quarters .....1 English Ell.
6 Quarters .....1 French Ell.

In respect to the above form, in which English Cloth Measure is usually stated in books, it is so far incorrect, that the French Ell so styled is imaginary, since it does not agree with the *Aune* or Ell used in France; and although the same objection does not apply to the Flemish ell, which either is or was very nearly equal to three quarters of an English yard, yet it appears absurd to load the memory, with the name of a measure never used in this country at all. Indeed the English ell itself has become obsolete as a measure, for the word ell is never mentioned between Drapers and their Customers, except when a piece of cloth is about one yard and a quarter in width, when it is usually termed *Ell-wide*.

(21) It may appear almost superfluous for me to point out, that the practice of measuring Artificers' work, and of measuring cloth, are entirely different in this country; and the same difference exists in all countries. The working Mechanic requires the use of a short measure like the foot, very accurately and minutely subdivided. The Draper, on the contrary, requires as his unit of measure, a longer dimension, such as the yard or ell, suited to the human arms, not stretched out to their full length, but very moderately extended so as to handle the cloth without over exertion. All nations have their peculiar standards of Cloth Measure, which generally vary from about 21 to 27 inches in length, except in France, where the *Aune* was nearly equal to 47 inches of English measure: but in some parts of the South of France, and of Spain and in Italy, the *Canne*, a much longer measure, varying from about 5 to nearly 8 English feet in length, was used for this purpose. The English yard appears to be a proper medium between those extremes, for the shorter measures must give unnecessary trouble by too many repetitions, whilst the longer ones cannot be handled so conveniently. Under these considerations I have given up the idea, which at first occurred to me, of measuring cloth in future by the foot, using for that purpose a 3 feet measure, not to be termed the yard. This arrangement would so far have simplified the proposed system of lineal

measure, that it would have got rid of one denomination, leaving the foot, and the fathom, as the only units of that kind of measure. On more mature reflection, however, it appeared that the improvement thus proposed would not be of sufficient importance, to outweigh the disadvantages of an entire change in the established system of measuring cloth in England, which has prevailed for many centuries; a departure from which might perplex and confuse the Public as well as Drapers and other Tradesmen, who sell goods by the yard, and to whom it might perhaps also give a little more trouble; as it probably would be more embarrassing in measuring the same quantity of cloth, to count successively 3, 6, 9, 12, 15, 18, 21 and 24 feet, by a 3 feet rod, using the foot as the unit; than to count 1, 2, 3, 4, 5, 6, 7 and 8 yards, using the yard as the unit. The only change therefore, or rather modification, that I shall suggest in cloth measure, besides adopting the new yard, which is to be exactly one half of the new fathom, and which accordingly will only differ from the present statute yard by one eightieth part in excess, is to divide this new yard into tenths and half tenths, instead of 16 nails.

(22) This arrangement will be as follows.

PROPOSED NEW TABLE OF CLOTH MEASURE.

2 Half tenths.....1 Tenth.
10 Tenths .....1 Yard.

By the above we will obtain the advantages of the Decimal Mode of Division, which will facilitate the pricing of goods by the yard, at the same time that the advantage of measuring off one quarter, one half, or three quarters of a yard, which are the fractional quantities most usually demanded, will not be lost; as two tenths and a half, five tenths, and seven tenths and a half, will mark those three fractions respectively. In regard to more minute fractional quantities, it is not the custom of trade in this country, to cut off less than one nail or one sixteenth of a yard. Hence if a person wishes to have eleven nails and a half of cloth, he must necessarily purchase twelve. Therefore, by dividing the new yard into twenty parts, instead of sixteen, more precision will be obtained, and the purchaser will more easily be able to accommodate himself without waste, than according to the present system.

(23) It is to be remarked that the expression *Nail* is never used by the Dealers in commodities sold by the yard, although not uncommon amongst their customers, for in the

bills of Drapers and other tradesmen who sell such goods, the quantities purchased are always stated in halves, quarters, eighths or sixteenths of a yard, as the case may be, The two last fractions, eighths and sixteenths, are not only more troublesome in calculation, but much more perplexing otherwise, than the tenths and half tenths, which I propose to substitute in lieu of them. For example, the following are the successive divisions of the yard according to the present system, namely, 1 sixteenth, 1 eighth, 3 sixteenths, 1 quarter, 5 sixteenths, 3 eighths, 7 sixteenths, 1 half, 9 sixteenths, 5 eighths, 11 sixteenths, 3 quarters, 13 sixteenths, 7 eighths, 15 sixteenths. The proper succession of these fractions is any thing but clear. Even a good Arithmetician, unless he be a Draper by trade, and therefore continually accustomed to them, requires some little time to perform a question of vulgar fractions mentally, before he can recollect in what order such fractions as 7 sixteenths, or 13 sixteenths follow the half, quarters, or eighth parts, into which the yard of English Cloth Measure is also divided.

(24) It has been held out as an important advantage of the present English system of Cloth Measure, that the binary divisions of the yard, which I propose to abolish, afford greater means of measuring with facility than any other. For it has been stated, that the half, quarter, eighth, or sixteenth of a yard of cloth, may be obtained by first measuring off one yard, and afterwards doubling or folding it as often as may be necessary. Admitting the practicability of thus doubling or folding, I deny the advantage of such a practice, and I must even deny that it is the custom of men of business. When a Linen Draper is asked for half a yard, or a quarter of a yard, of cloth or of ribband, he measures and cuts off the precise quantity demanded at once. If he were to adopt the roundabout process of first measuring a whole yard, then doubling it by folding once to measure the half yard, or twice to measure the quarter yard, before he cut off the quantity required, he would give himself a great deal of unnecessary trouble, and would be laughed at by his customers. Almost the only case to which the above system can apply, is the purchase of a pair of shoestrings, in which the purchaser would demand the quantity necessary for two, which he would double and cut afterwards. But this advantage results from the flexibility of the material, and not from the binary divisions of the yard, for if the purchaser were to consider 2 feet $9\frac{3}{10}$ inches of ribband, as the precise quantity necessary for two shoe-

strings, and were to obtain that quantity by measure, he might divide it into two parts by folding, just as easily as if it were an exact yard; although the above complex dimension contains feet, or third parts of the yard, which are divided first into inches or thirty-sixth parts, and secondly into tenths of an inch, or three hundred and sixtieth parts of the yard; which fractions are all essentially different from the binary divisions either of the yard or of the foot.

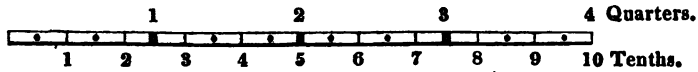
(25) Almost every person knows, that although Artificers' work is calculated by superficial measurement, cloth is never estimated in this manner. For example, if the floor of a room measure 15 feet by 21, the boarding necessary to cover the joists is estimated at 315 superficial feet, being the product of those two numbers multiplied together, and the Carpenter is paid for his work accordingly. The same dimensions stated in yards are 5 by 7, but instead of estimating the cloth for a carpet to cover such a floor at 35 superficial yards, being the product of the last two numbers; the person who is to lay down the carpet, considers how many breadths of cloth are necessary to cover the given width of the room, which number must depend also upon the width of the cloth, allowing a little extra for the seams, where two adjoining breadths are sewed together. Having determined the number of breadths, which in cloth less than yard wide, would be more than 5, but in cloth more than yard wide would be less than 5, which is the supposed width of the room in yards; he multiplies this number by 7, the length, and the product is the proper quantity of cloth of the pattern and breadth chosen, stated in lineal not in superficial yards. Thus no two dimensions of Cloth Measure ever require to be multiplied together, in estimating the quantity of cloth necessary for any given purpose. This consideration is of importance, as it rendered it unnecessary for me, to propose carrying the decimal divisions of the yard lower than tenths and half tenths.

(26) The principle of this arrangement, which will appear sufficiently obvious to an Arithmetician, is as follows: any number involving a decimal, may be multiplied conveniently by a second number involving not only a decimal, but also the half or quarter of its own last place of decimals; but two numbers, both involving not only decimals, but halves or quarters of the last place of decimals of each, cannot conveniently be multiplied together, without previously clearing away the vulgar fraction from one of them, by reducing the whole expression into the decimal form.

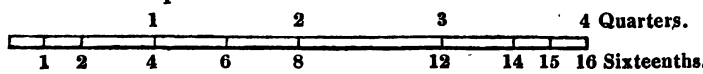
(27) In conformity with this principle, I have subdivided the foot of lineal measure into 100 decimal parts, because in the accounts of Artificers' work, not only two, but even frequently three dimensions, stated in feet and parts of a foot, require to be multiplied together, in order to obtain some quantity, which is afterwards multiplied by the price for value; whereas in calculations relating to Cloth Measure, only one multiplication takes place, the quantity stated in lineal yards being multiplied into the price, in order to obtain value.

(28) The conveniency of the proposed new mode of division of the yard, which is the unit by which the price of cloth is regulated, cannot however be fully appreciated, except by considering also the subdivisions of the unit of price. I shall therefore postpone the consideration of the propriety of the change from the binary to the decimal division of the yard, until our national system of money shall also have been discussed.

(29) In respect to the actual marking of the proposed new divisions and subdivisions upon the rod, used as a yard measure, which ought to be so done, that the Draper can easily distinguish each several fraction of the yard, by inspection, without numeral figures being also marked upon it; it appears to me, that the half yard, and the two quarter points, as being the most important, may be marked by double circular lines carried round the rod, whilst the eight remaining tenth parts may be marked by single circular lines, and the eight remaining half tenths, by dotted circular lines, as represented in the annexed figure.



Having divided and marked a light coloured rod of the proper length in this manner, by black circular lines and dotted lines, the dimensions appeared very clear and convenient for use: indeed rather more so than those of the common yard rod of our present Cloth Measure, which are represented in a second figure also annexed, to enable the reader to compare the two.



It will be observed that, according to custom, one quarter of the common yard rod, the second from one end, is left undivided. The remainder of the rod is divided into eighths,

of which the first and last only are subdivided into sixteenths. This arrangement renders it impossible to measure all the necessary fractions of the yard, such as 11 sixteenths, &c. at one measurement. Practice, however, renders it convenient enough to tradesmen; and if every sixteenth were marked, it probably would be too confused for common use, unless all the divisions were numbered like those of the Carpenter's rule.

(30) I shall conclude this part of my subject by observing that the three units of the lineal measure proposed, namely the foot, the fathom, and the yard, being each confined to its own particular department, the measurements made by any one of these three will seldom require to be reduced into terms of either of the two others. If, however, such reductions should occasionally be necessary, these units are all such simple aliquot parts or multiples of each other, that nothing can be more easy than the calculations necessary for effecting them.

(31) The next in order after lineal are superficial measures, which shall now be considered, and which are of two descriptions; first, those which apply to the measurement of Artificers' work generally, and secondly, such as apply to Agricultural and Geographical purposes. It is well known, that the first is termed Square Measure, the second Land Measure. The former is used for much smaller measurements than the latter, and therefore it is usual to treat of Square Measure first: but it will be most convenient, in reference to our present subject, to reverse this order, because Square Measure and Solid Measure, the latter of which will follow superficial measure, are so intimately connected together, that it will be best not to break the chain of connection between these two.

(32) For this reason I shall commence with Land Measure, which is as follows.

OF THE PRESENT STATUTE ENGLISH LAND MEASURE.

9 Square Feet	1 Square Yard.
30¼ Square Yards	1 Square Rod or Perch
40 Perches	1 Rood.
4 Roods, or 4840 Square Yards	1 Acre.
640 Acres	1 Square Mile.

Nothing can give a more striking proof of the complexity of the Old English system of measures than the above. For if we suppose a field, or any other piece of land, to be measured in yards and feet, and the superficial con-

tent to be deduced from thence by calculation, according to the appropriate rules of mensuration of surfaces, the number thus found in square feet, must be successively divided by the numbers 9, 30¼, 40, and 4, in order to reduce it into English acres and parts of an acre. This is a very troublesome operation, and yet there is absolutely no other possible method of calculating areas than the above, if our old national measures be exclusively adhered to.

(33) The difficulty attending the embarrassing process, which has just been described, led to the adoption of that very useful instrument, the Surveying Chain of 22 yards, also called Gunter's Chain, from the name of its ingenious inventor,* which being subdivided into 100 links leads to the determination of the number of acres in any piece of ground, by a very easy process; because this new element of our superficial measure is a decimal part of the acre, as shown in the following Table.

OF THE PECULIAR SUPERFICIAL MEASURE, USED IN LAND SURVEYING.

100,000 Square Links, or 10 Square Chains....	1 Acre.

By means of this arrangement, the area of a piece of ground measured by the chain of 100 links, is first calculated in square links, and then the content is immediately reduced into English acres, and decimal parts of an acre, by merely striking off 5 places of decimals, the value of which decimals in roods and perches is found by multiplying them by 4 and by 40. Such are the advantages of this system, that the chain, although not established by law, is the sole measure used by the Land Surveyors of this country, which they adopted by universal consent nearly two centuries ago.

(34) Notwithstanding the facilities thus afforded, the English Statute Acre of 4840 square yards, and its parts, are such very awkward multiples of the statute yard, and foot, whilst the acre itself is such an inconvenient fraction of the square mile, that I beg to suggest the following new system of Land Measure in preference.

* Who also invented the Gunter's scale for performing calculations, the principle of which has been very ingeniously and usefully applied to the sliding rules of the Gager and of the Timber Measurer, noticed in Article 15.

PROPOSED NEW LAND MEASURE.

For general Purposes.

100 Square Links .....1 Square Fathom.
1000 Square Fathoms .....1 Imperial Acre.
1000 Acres .....1 Square Mile.

For Land Surveying, exclusively.

100,000 Square Links, or 10 Square Chains.... } 1 Acre.

The fathom, chain and mile are the new fathom, the new chain of 10 fathoms, and the nautical mile, before suggested in treating of the improvement of our lineal measures.

(35) It will perhaps be allowed, that nothing can be more simple or more convenient, than this arrangement would be, if once adopted; and I think the advantages are such as completely to outweigh any difficulty, that might at first occur from the change. The reduction of the old English acre and of its parts into terms of the new acre is a matter of calculation, troublesome to be sure, but it is not an every day operation; so that this reduction of the various portions into which the property of any Landed Proprietor may be subdivided, having been once performed, which could only occupy an intelligent person for a few days, as applied to an estate of moderate size, would hold good for ever, without requiring a new survey; that is supposing the estate to have been previously surveyed accurately according to the old method. In respect to future surveys, the adoption of the new Land Measure suggested will be the greatest possible improvement upon the present system.

(36) To add to the difficulties which have hitherto arisen from the complex nature of the English Standards of Land Measure, it is to be observed, that even the Statute Acre of 4840 square yards does not prevail universally throughout the whole of the United Kingdom. The Statute Scotish Acre before the Union was equal to 6150·4 square yards, while the Statute Irish Acre was equal to 7840 square yards, besides which there are numerous customary acres differing from those standards and from each other, both in Scotland, and in Ireland. The same confusion prevails in England and Wales, where there are more than twenty customary acres, varying in magnitude from one half of a Statute English Acre to nearly an acre and a half, with the exception of one only, the customary acre of Staf-

fordshire, which is nearly equal to 2¼ Statute acres. Such were and still are the irregularities attending the old Land Measures of Britain and Ireland, which the new Land Measure above suggested offers the simplest and most convenient mode of removing.*

(37) To distinguish between the present statute acre, the various customary acres, and the new acre suggested, I have proposed that the last shall be called the *Imperial Acre.*

(38) In using the new system, I would recommend, in respect to all deeds and documents relating to the sale of Landed Property, and all plans of ground surveyed, that the superficial content of each field or portion should be stated in acres, square fathoms, and hundredth parts of the fathom; but in rough estimates and in conversation, the same may be stated in acres and quarters, or in acres, tenths, and half or quarter tenths, it being understood that the tenth of the new acre is the square chain of 100 square fathoms.

Thus for example, a field of 57 imperial acres 252 square fathoms and 17 square links should be stated in a law paper or plan as 57 imperial acres 252·17 fathoms, but in common conversation it may be stated as 57 acres and a quarter: whilst a field of 57 imperial acres 378·76 square fathoms may be stated in conversation as 57 acres 3 tenths and 3 quarters. The latter might also be expressed as 57 acres 3 chains and 3 quarters, but although the square chain is well known to Land Surveyors, it is not understood by the people in general, and might occasion doubts as to quantity; whereas the fraction 3 tenths and 3 quarters of any unit explains itself, and cannot possibly perplex or lead to the smallest ambiguity, and there is no person so ignorant, but that he may from this expression form a clear notion of the quantity intended.

(39) It is proper to observe, that the present English Statute Acre will be to the new Acre proposed as 1 to 0·8474089 nearly, and that the present Statute English Square Mile will be to the new square Mile proposed as 1 to 1·3240686 nearly. Hence as useful approximations, when great accuracy is not required, 6 acres of the present will be equal to about 7 acres of the new land measure proposed, and 4 square miles of the present will be equal to about 3 square miles of the new land measure.

* See the Appendix to the second Report of the Commissioners on Weights and Measures, which was ordered to be printed by the House of Commons on the 18th September 1820.

(40) Generally speaking, so far as regards common measures in daily use, the application of an old name to a new quantity is to be reprobated, unless they be very nearly equal: and I should even have preferred adopting a new term for the proposed new division of land of 1000 square fathoms; if two very strong reasons did not urge the retention of the word *Acre*. First, there is no other term that would be so intelligible to the people of England, who have always estimated quantities of land by the acre. Secondly, the sale of Estates and the letting of Farms are not every day transactions, like the sale of goods in a market, so that neither of the parties in treaty about a piece of land are likely to lose by an error in quantity, owing to a mistake between old and new measure, such as might or rather must frequently arise, on first changing any measure in general and daily use, such as the gallon. Moreover the term *imperial* as applied to the bushel and quarter of corn, has already become familiar to the agricultural population of this country, who know that this term implies a moderate change from the former standards of those measures. Hence the application of the same term *imperial* to the word acre will put them sufficiently on their guard against error, as they will know by analogy, that the imperial acre must imply a new acre differing in a moderate degree from the statute acre, and differing also from the several customary acres of the British Empire. And when they are informed that this new acre is exactly equal to 1000 square fathoms, and also to the one thousandth part of the new square mile; these very simple proportions will fix the precise value of the imperial acre in their memory, in a manner never to be forgotten. Besides which, the approximation of six to seven, stated in the preceding article, is simple enough to enable the comparative value of the new and old acre to be easily remembered, and yet sufficiently accurate for the common purposes of conversation.

(41) I shall conclude this part of my subject by observing, that the same very great disadvantage noticed in Article 12 attends not only our present lineal measures, but also our present land measure, which it embarrasses in a still more injurious manner. For example, when a tract of country is said to consist of 297 square miles, no one can tell or scarcely even guess, how many statute English acres, still less how many perches or square yards of land, are contained in such a quantity. These are intricate questions in Arithmetical Reduction, which can only be solved, by a

troublesome calculation, first multiplying the numbers 297 and 640 together, to obtain acres, and afterwards multiplying this product by 160 to reduce the acres into perches, or by 4840 to reduce them into square yards. But few persons, who read or hear of the content of any tract of country in square miles, are willing to undertake these troublesome calculations; and what is more, I believe I may venture to assert, that there is not above one man in a hundred, taking the average of the population of the British dominions, who knows how many acres there are in a square mile, or how many square yards there are in an acre. He may have been taught these proportions as a school boy, but he necessarily forgets such complex numbers as 640 and 4840 in after life; unless he be an Engineer, a Land Surveyor, or a Schoolmaster, who are in the frequent habit of such calculations. Hence if any person not of those professions, on hearing of a tract of country of 297 square miles, should be desirous of knowing how many acres, perches or square yards are contained therein; it is not sufficient for him to be an Arithmetician to unravel this mystery. If he should not happen to have a book of English Weights and Measures in his pocket, which is very improbable, he must go or send for such a book, before he can even commence the troublesome calculations, by which alone he can solve this problem. Upon the whole therefore, although the agricultural population of this country may have a clear notion of fields or other small quantities of land stated by the acre, yet they have no distinct idea of larger quantities stated by the square mile: and as for the great mass of the British nation, who are not employed in the cultivation of the soil, they can form no more idea of quantities of land expressed in the Statute Land Measure of their own country, than if the same were stated in the land measure of the ancient Egyptians or Babylonians.

The above embarrassing obscurity, and confusion of ideas, will be completely removed by adopting the New System of Land Measure proposed; for in this case, the value of any quantity of land, stated in any one denomination, will be known at once in terms of any other denomination of the same measure, whether higher or lower, without the trouble of calculation, and even without any effort of the mind. For example, 297 square miles of the new measure will be known at once to be equal to 297 thousand acres, and to 297 millions of square fathoms; and vice versa. The great advantages of this improvement will scarcely be disputed.

(42) We will now proceed to the consideration of the other kind of superficial measure used in this country, which is as follows.

OF THE PRESENT ENGLISH SQUARE MEASURE.

144 Square Inches.....1 Square Foot.
9 Square Feet.....1 Square Yard.
100 Square Feet.....1 Square.
272¼ Square Feet .....1 Square Rod.

To simplify this system, which as I said before applies exclusively to the measurement of Artificers' work, and to purposes connected with Architecture or Mechanics; I propose that the square foot shall in future be the only unit, and that all calculations of area or superficial content shall be made in feet, and decimal parts of a foot, rejecting of course the square yard, and the square rod, but not the Artificers' square of 100 superficial feet, this being a very convenient and useful decimal multiple of the foot.

(43) The new system under consideration will therefore be as follows.

TABLE OF NEW SQUARE MEASURE PROPOSED.

100 Square Digits.....1 Square Foot.
100 Square Feet.....1 Square.

(44) To judge of the advantages of the change proposed, it will be necessary to consider in what manner, the present system of superficial measure is applied to practical purposes, such as the measurement of the boarding of floors, of window shutters, bookcases, &c.

In such measurements the builder has a right to measure, to calculate, and to charge, to the extreme of accuracy, if he chooses; but in common floors it is not worth while to include any dimension less than an inch. In this case all fractional parts of an inch are got rid of, by the system of *giving and taking*, as it is technically termed: that is to say all dimensions less than half an inch are entirely rejected, whilst a full half inch or more is allowed to the Builder as one inch. Hence if a common boarded floor should measure 17 feet 5⅝ inches by 25 feet 9½ inches, it would be measured as a floor of 17 feet 5 inches by 25 feet 10 inches. This is technically called *measuring to the inch*, which implies that no dimension smaller than an inch is noticed. In wainscot floors finished in a superior manner, it is usual to measure to the half inch, that is to say to include half inches but not any lower dimension, by the same principle of re-

jecting every fraction less than a quarter of an inch, and of allowing a full quarter as half an inch. In Joiner's work of still greater value, the custom is to measure to the quarter inch; that is to say, feet, inches, and quarters only appear in the Builder's measurements and calculations, all fractions less than the quarter of an inch being excluded.

(45) This principle of giving and taking is evidently a very equitable one, since in works of any magnitude, fractions less than the half or more than the half of any minute dimension, are likely to occur nearly in equal number; so that neither the person who performs the work, nor he who pays for it, are liable to lose by this arrangement. In respect to whether the measurements shall be by the inch, the half inch or the quarter, the Builder who contracts, and the Architect, Surveyor, Clerk of Works, or other person employed to check his measurements, decide this point by mutual consent, each knowing, in reference to the price agreed upon, to what degree of accuracy it is necessary to go, in order that a just average value of the work performed may be obtained.

(46) As an example of this kind of measurement, let us suppose a wainscot floor to measure 59 feet $10\frac{1}{4}$ inches in length, by 27 feet $7\frac{3}{8}$ inches in breadth, and that the parties have agreed to measure to the half inch, in which case the $\frac{1}{4}$ and the $\frac{3}{8}$ths will each be allowed as half an inch. To obtain the quantity of flooring executed in superficial measure, the product of those two dimensions must be found, which is always done duodecimally or by cross multiplication; in which process all fractions of an inch must previously be reduced to twelfth parts of an inch, in order to suit the duodecimal system. Hence the above dimensions stated duodecimally are 59 feet 10 inches and 6 twelfths, and 27 feet 7 inches and 6 twelfths, which being multiplied together yield a product of 1654 superficial feet, 0 parts of the second order, 6 parts of the third, and 9 parts of the fourth order, each of these parts in duodecimal multiplication being the twelfth part of the denomination immediately preceding it. But the superficial content, after being thus obtained, is never stated in lower terms than feet, and parts of the second order. This is done by the same principle of giving and taking before mentioned, all fractions less than 6 parts of the third order being rejected, and all fractions of 6 parts of that order or more being allowed as one second. Hence the above product would be stated in a Builder's account, as 1654 feet 1 inch superficial, the term inch being im-

properly applied by practical men to the twelfth part of the superficial foot. In consequence of this misnomer, the above expression, which by any one not thoroughly acquainted with such measurements, would naturally be understood as implying 1654 superficial feet, and 1 superficial inch, means in reality 1654 superficial feet and 12 superficial inches.

(47) Now to persons, who have not been accustomed to this mode of calculation almost from infancy, and made it the chief business of their lives, as many men do, nothing can be more troublesome perplexing and liable to error, than the duodecimal multiplication of dimensions, each consisting of feet, inches, and 12 parts of an inch, like those before specified. In the above calculation for example, if pushed to the extreme of accuracy, as supposed, there are no less than nine several products to be obtained, in all of which excepting one, namely the product of the feet into the feet, the number obtained is to be divided by twelve, the remainder set down and the quotient carried. Thus instead of the simplicity attending the common multiplication, or decimal multiplication of numbers, each step of this complex process involves Multiplication, Division, and Subtraction.* It is difficult to conceive any system more embarrassing than the above; and yet there is absolutely no remedy for it but the rejection of the inch altogether, and the substitution of the digit or decimal division of the foot instead of it. For so long as dimensions shall be measured in feet and inches, the duodecimal mode of multiplication with all its inconveniencies must prevail; because the reduction of feet, inches and parts of an inch, into feet and decimal parts of a foot by calculation, is in itself a very troublesome operation, and would take up nearly as much time as the squaring of simple dimensions by the duodecimal method; besides which inches and eighth or twelfth parts of an inch, the present elementary subdivisions of the English foot, are fractions of a foot seldom reducible into two places of decimals without some awkward remainder.

(48) If however the English lineal measure were changed from feet, inches and parts of an inch, to feet, digits

* Some persons prefer performing their calculations by Compound Multiplication, for the feet, and by Practice for the inches and parts, instead of direct Duodecimal Multiplication. Both methods are troublesome in the extreme; but in large numbers of feet, this last is perhaps the easiest of the two. Expert measurers, use them both combined, and by long habit are capable of getting through these complex calculations, with extraordinary facility.

and tenth parts of a digit, and all measurements were hereafter made by the new system; no such remainder, or minute fraction less than the tenth part of a digit would ever occur, for all Architects would of course abstain from them, in like manner as they now always avoid very minute fractions of the present inch, in planning the woodwork of a building. And in measurements for the determination of the value of work executed, the same principle, by which all fractions less than the quarter of an inch, or the forty-eighth part of the foot, are now rejected, might be applied in decimal measurement, to the rejection of all fractions less than one-fifth of a digit, or the fiftieth part of the new foot.

By adopting these arrangements, the practice of the new system of measurement proposed will be assimilated to that which is now used by men of the building profession, with no other change than the adoption of the decimal, instead of the duodecimal divisions of the foot, for their preparatory lineal measurements.

(49) When applied to superficial measurements, the subject of our present inquiry, this change will be of the greatest importance, by rendering those calculations simple and easy, which are now extremely complex and difficult.

As a practical example of the inferiority of the present to the new system proposed, I shall subjoin the calculation of the superficial content of the wainscot floor before-mentioned in Article 45.

(50) *First, by the common Duodecimal System of Lineal and Superficial Measure.*

To find the quantity of boarding of a floor 59 feet 10½ inches long by 27 feet 7½ inches wide.

	Ft.	In.	Pts.	
	59	10	6	
	27	7	6	
(*a*) (*b*) (*c*)	1616	7	6	
(*d*)	34	11	1	6
(*e*)	2	5	11	3
Feet super.	1654	0	6	9 Answer.

This answer, which as was before mentioned, would be stated as 1654 feet 1 inch superficial (by contraction super.) in a Builder's account, cannot be obtained without the small extra calculations (*a*) (*b*) (*c*) (*d*) and (*e*), which would require to be done on waste paper, and which are as follows.

Extra Calculations necessary, to obtain the above.

(*a*) 27 × 6 = 12)162 = 13 6

(*b*) 27 × 10 = 270 = 12)283 = 23 7

(*c*) 59 × 27 = 413 + 118 = 1593 + 23 = 1616

(*d*) 59 × 7 = 413 × 6 = 12)419 = 34 11

(*e*) 59 × 6 = 354 × 5 = 12)359 = 12) 29 11 = 2 5 11

(51) ***Secondly, by the new Decimal System of Lineal and Superficial Measure proposed.***

To find the quantity of boarding of a floor 59 feet 8 digits 8 tenths long, by 27 feet 6 digits 2 tenths wide.

Feet.
59·88
27·62
11976
35928
41916
11976

Feet super. 1653·8856 Answer.

The result of this very simple process, after striking out superfluous decimals, is therefore 1653 superficial feet, and 89 hundredth parts, or superficial digits.*

(52) My readers will now see, that the duodecimal method requires about three times as many figures, as the decimal method of performing the same operation. But if they should be disposed to repeat both calculations themselves, they will find on trial, that the former is attended

* The reason of the trifling difference between this and the former answer, which must be sufficiently obvious to an Arithmetician, will be explained afterwards, in Article 71.

with more than threefold trouble, for besides the extra calculations before mentioned, there are several similar calculations, which increase the work, although they do not appear to the eye, as they may be performed mentally.

(53) To return to the present system of measuring Artificer's work, after the content of a piece of work has been found by squaring, or by the duodecimal multiplication of its lineal dimensions, it is next reduced into superficial yards, squares or rods, by dividing the number of superficial feet by 9, or by 100, or by 272, omitting the fraction $\frac{1}{4}$; accordingly as the agreement for executing it may have been made by the yard, by the square, or by the rod. The system of measuring by the superficial yard is I believe occasionally used in the North, but not in the Metropolis or in the South of England, where Painters' Carpenters' and Joiners' work are measured by the square, and Brickwork by the rod, in the manner that shall now be explained.

(54) Brickwork is the only kind of work measured superficially, that is not of uniform thickness or depth, or nearly so. Brick walls on the contrary vary in thickness, not only in different buildings, but in different parts of the same building. All those varieties are however reduced to the standard of one brick and a half thick, by a simple process. Thus for example, 180 superficial feet of brickwork 2 bricks thick, are equal to 240 superficial feet of the above mentioned standard thickness, whilst 180 superficial feet of brickwork 1 brick thick, are equal to only 120 of the standard thickness. After having reduced the whole quantity of brickwork that has been executed, and measured in superficial feet, to the above standard thickness of $1\frac{1}{2}$ brick, it is next reduced from feet into rods, in which denomination the accounts of Builders are made out.

(55) This system is attended with a great deal of unnecessary trouble. If the rod were itself made the unit of lineal measurement, there would be less absurdity in retaining such a system; but this neither is nor ever can be the case, for that absurd fractional measure is too long, and unwieldy for such a purpose. Architects, Builders, &c., therefore always measure brickwork by a ten feet or by a five feet rod, divided into inches and quarters, and they always calculate the superficial content in feet, before they reduce it into rods. Hence the abolition of the superficial rod would be a very great improvement.

(56) As a practical example, if we suppose that a Builder has contracted to execute the brickwork of a

building at 10*l.* 15*s.* 4*d.* per rod, and that after being measured, and reduced to the standard thickness above specified, the quantity amounts to 28797 superficial feet. This number being divided by 272 yields 105 rods, and 237 feet. To find the value of the above at 10*l.* 15*s.* 4*d.* per rod is a very tedious and troublesome calculation; and it is evident, that almost all measurements by the rod must necessarily be equally complex with the above; for very few measurements of brickwork indeed can reasonably be expected, to involve an integral number of rods without a remainder. Now if the rod were abolished, as I recommend, in which case brickwork might be priced by the superficial foot reduced to the standard thickness of 1½ brick, nothing more would be necessary, than to find the value of 28797 feet of brick work, at the equivalent price of 9½*d.* per foot, which is an exceedingly simple calculation. If any person will take the trouble to calculate the value of the supposed brick work, first by the rod, and secondly by the foot, he will find that it may be done by the latter method in one fourth part of the time, and with infinitely less risk of error, than is practicable by the former. For the sake of those readers, who may not be inclined to go through these two calculations, the work of both shall be subjoined.

(57) ***First, according to the present System of pricing brickwork, by the Rod.***

28797 Superficial feet at 10*l.* 15*s.* 4*d.* per rod.

Ft. Super.
272)28797(105 Rods 237 Ft.
272
1597
1360
237

As 1 Rod : 105 Rods 237 Ft.
Or as 272 Ft. : 28797 Ft. } : : 10*l.* 15*s.* 4*d.*

2584 | 20
115188 | 215
230376 | 12
143985 |
57594 | 2584 *d.*
74411448

272)74411448(273571½ *d.*
544
2001
1904
971
816
1554
1360
1944
1904
408
272
136 ÷ 272 = ½
d.
12) 273571½
2,0) 2279,7 7½

Answer. 1139*l.* 17*s.* 7½*d.*

(58) *Secondly, according to the new System proposed, of pricing Brickwork by the Foot.*

28797 superficial feet of brickwork at 9½*d.* per foot.

Ft. Super.
28797
9½
259173
14398½
12) 273571½
2,0) 2279,7 7½

Answer. 1139*l.* 17*s.* 7½*d.*

The above will serve as a specimen, convincing to the eye as well as to the understanding, of the absurdity of retaining that worse than useless fractional measure of the dark ages, the rod of 272¼ superficial feet, which causes a very simple calculation to be unnecessarily embarrassed by an operation of long division, the most troublesome and liable to error of all the four fundamental rules of Arithmetic, as well as by a question in the rule of three, involving a

repetition of the same troublesome process, and which thus multiplies fourfold the labour of that, which would otherwise be extremely easy.

(59) The same objection does not apply to the square of 100 superficial feet, as there is no trouble in dividing by 100. Indeed, it is necessary that there should be a measure of this description, for pricing very cheap work. For example, if the just value of any piece of work be about one halfpenny per superficial foot, it would be very inconvenient to price it by the foot, for one farthing per foot might be attended with considerable loss to a contractor, and three farthings per foot might produce an exorbitant rate of profit. It should therefore be priced by the square of 100 superficial feet, which will be found a great deal simpler and more advantageous, than the former system of pricing artificers' work by the rod. Indeed the pricing of work by the square is equally simple with, and gives no more trouble in calculation than, the pricing of the same work by the superficial foot, the comparative advantages of which over the system of pricing by the rod, have already been exemplified in the two foregoing articles.

(60) The same reasons, which urge the abolition of the rod, apply also to the square yard, which ought to share the same fate. It is true that measurements by the square yard are less troublesome, than those by the square rod, inasmuch as it is less difficult to divide by 9, than by 272. Still the thing is unnecessary, and therefore the square yard also should be banished from our superficial measures; for surely the time of men of business may be more usefully or agreeably employed, than in dividing by 9, those quantities, which it is much better to leave undivided.

(61) It is proper to remark, that the present superficial foot will be to the new superficial foot proposed, as 1 to 1·02535876, or as 39 to 40 nearly. Hence as an useful approximation, when great accuracy is not required, the reduction of the present into terms of the new, or of the new into terms of the present superficial measure, may be effected, by subtracting or adding one fortieth part of itself from or to any given number of superficial feet stated.

(62) We will next proceed to measures of solidity.

OF THE PRESENT ENGLISH MEASURES OF SOLIDITY.

1728 Cubic Inches .....1 Cubic Foot.
27 Cubic Feet .....1 Cubic Yard.

This is the form in which solid measure is usually stated in books, which excepting that the cubic inch is a very in-

convenient fraction of the cubic foot, and the latter by no means a convenient fraction of the cubic yard, may appear sufficiently simple, being embarrassed with fewer denominations than usually occur, in the other tables of English measure. The solid measurements relating to Artificers' work are never carried higher than cubic feet, but those of Labourers' work, after being first calculated in cubic feet, are afterwards reduced into cubic yards, it being the universal custom of this country, to price Labourers' work by the cubic yard.

(63) Notwithstanding the apparent simplicity of our solid measure, as it appears in the above table, it is in reality attended with the greatest disadvantages. The combination of feet, inches and twelfth parts of an inch, in calculation, causes the same embarrassment in our cubic as in our superficial measurements, or rather more; for in calculating cubic content, three dimensions must always be multiplied together by the duodecimal method, whilst in calculations for superficial content, only two are required. And so far as regards Labourers' work in particular, every quantity being first calculated in cubic feet as a matter of necessity, it may be allowed, that the intervention of the cubic yard tends only to give useless trouble. In short this quantity is objectionable in solid measure, for the same reason which induced me to object to the square yard of superficial measure, in Article 60, but of the two the cubic yard is the most objectionable, inasmuch as it is more troublesome to divide by 27 than by 9. But as the cubic foot itself is much too small a dimension, to be assumed as the unit for pricing Labourers' work, I propose that 100 cubic feet shall be used for that purpose, in like manner and for the same reason, that the square of 100 feet is applied to superficial measure, for pricing those articles, which could not conveniently be priced by the superficial foot.

(64) The hundred cubic feet measure will not only afford a much simpler means of arriving at quantity and price; but it is also a more convenient measure of Labourers' work than the cubic yard of 27 feet, inasmuch as it approaches more nearly to the day's work of an able-bodied excavator in difficult soil.

(65) I therefore beg to suggest the following in lieu of our present measures of solidity, viz.

TABLE OF NEW CUBIC MEASURE PROPOSED.

1000 Cubic Digits.....1 Cubic Foot.

In reference to the above it only requires to be understood, that Artificers' work is to be priced by the cubic foot, and Labourers' work by the hundred cubic feet.

To enable the Reader to judge of the comparative advantages of this new system, I shall subjoin a practical example of Carpenters' work, and another of Labourers' work, measured and calculated by both methods.

(66) It is proper previously to explain, that Carpenters' work is only measured to the inch, so far as regards length, but it is measured to the quarter of an inch, so far as regards the scantling of the several pieces. Therefore in finding the solid content of a piece of timber by the foot as the unit, since there may be one place of duodecimals in the length, two in the width and two in the depth, this will occasionally produce so many as five places of duodecimals in the product, by which cubic content is first found. But in making out his bill, the Builder always throws out superfluous duodecimals, that is parts of the third, fourth and fifth order, by the same rule of giving and taking, which was described in Article 46, as applying to superficial measure.

It may further be remarked, that the like parts of a floor or roof, such as the joists of the former, and the rafters of the latter, are usually ordered to be made of the same length and scantling, so that in a new Barrack for Troops, or in a new row of houses in a Town, built on the same plan, there may be a great number of pieces of timber all nearly alike, that is not differing more than perhaps a quarter of an inch in length, or an eighth of an inch in either of the two dimensions constituting the scantling.* In examining the work executed, the Architect has a right to reject every piece, which is not of the full size prescribed in his specification; but this severity is not usually resorted to, provided that there be only a few undersized pieces, and the defect trifling; and provided also that the greater number are either full sized, or a little exceeding the full measure. In this case, they are all received as being of the exact scantling, previously fixed by the Architect, although many of them may be an eighth or even a quarter of an inch more, and some few an eighth of an inch less, than the said scantling.

(67) It is also proper to explain, that the first quantity obtained by calculation in an account of Labourers' work, previously to its being reduced into cubic yards, is always

* The term scantling implies the width, and the depth or thickness, of a piece of timber.

stated exclusively in cubic feet, by rejecting all fractions less than 6 twelfths of the cubic foot, improperly called 6 inches cube, and by allowing all fractions of 6 twelfths or upwards as 1 foot. When reduced to cubic yards it may either be stated in yards and feet cube, which is the most accurate method, or it may be stated in yards and quarters of a yard, by common consent of the parties concerned.

These particulars being explained, we will now proceed to the practical examples promised.

(68) *First Example, by the Duodecimal System in common use.*

To calculate the solidity of 409 common rafters, each 23 feet 11 inches long, $2\frac{3}{4}$ inches wide, and $4\frac{1}{4}$ inches deep.

	Ft.	In.		In.	Pts.		In.	Pts.		
	23	11	×	2	9	×	4	3	×	409
		2		9						
	3	11		10						
(*a*)	1	5		11	3					
	5	5		9	3					
		4		3						
	1	9		11	1	0				
		1		4	5	3	9			
(*b*)	1	11		3	6	3	9	×		409
							5			
	9	8		5	7	6	9			
							8			
	77	7		9	0	6	0			
							10			
	776	5		6	5	0	0			
(*c*)	17	5		7	8	9	9			
Ft. Cube.	793	11		2	1	9	9	Answer.		

Extra Calculations to obtain the above.

(*a*) 23 × 9 + 8

9

12) 215

12) 17 11

1 5 11

(*b*) $409 = 400+9 = 40\times10+9 = 5\times8\times10+9$

(*c*)

1	11	3	6	3	9	
					9	
17	5	7	8	9	9	

The answer, or quantity obtained by the above calculation, would be stated in a builder's account as 793 feet, 11 inches cube, the superfluous places of duodecimals being rejected, and the term *inches cube* being improperly applied to twelfth parts of the cubic foot, as was before mentioned.*

(69) *The same Example by the new Decimal System proposed.*

To find the solid content of 409 rafters, each measuring 23 feet $9\frac{1}{10}$ digits in length, $2\frac{3}{10}$ digits in width, and $3\frac{5}{10}$ digits in depth.

Feet.	Ft.	Ft.	
23·91	× ·23	× ·35	× 409
·23			
7173			
4782			
5·4993			
·35			
274965			
164979			
1·924755			
409			
17322795			
76990200			

Ft. Cube. 787·224795 Answer.

The quantity thus obtained would be written as 787·225 cubic feet, and might be read as 787 cubic feet and 225 cubic digits, after striking out superfluous decimals.

(70) On comparing these two methods of performing

* Most classical scholars will no doubt be aware, that this ambiguity would not have occurred in the Latin language, for the word *uncia*, from which the English words *inch* and *ounce* are both derived, signified the twelfth part of any unit of measure or of weight, instead of being confined to that fraction of the lineal foot alone, as with us. Hence the uncia was not only the inch of the Roman foot, and the ounce of the Roman pound, but also the twelfth part of the *Jugerum* of Roman Land Measure; and accordingly the Roman Artificers might have used the terms inch superficial or inch cube, like our English Artificers of the present day, but without ambiguity or impropriety.

the same calculation, the Reader will see, that there are nearly twice as many figures in the duodecimal calculation, notwithstanding the method adopted, of multiplying the content of one rafter continually by the successive factors, 5, 8 and 10, and adding 9 times the same content to the last product, in order to save the trouble of multiplying by 409; which is an arrangement by no means obvious; so that it either might not occur at all to a person who was not very expert at such calculations, or he might take a long time in finding it out: and if this method had not been resorted to, the duodecimal calculation would have required a much greater number of figures, than actually appear in it. In fact I have favoured this mode of calculation, by doing it in the shortest possible manner; and yet it is to be remarked, that in addition to the extra calculations, marked (*a*) (*b*) and (*c*), there are a number of others, that must be done mentally, and all of which give additional trouble, although it is not necessary to write them down on a waste part of the paper, like the former. Hence there is more than twice as much of trouble, difficulty and risk of error, attending the duodecimal system of calculation, in the example before us, than are involved in the decimal calculation of the same, which consists simply in finding the continued product of four numbers, by common multiplication.

(71) It may perhaps be observed, that the quantities found by these two methods, do not exactly agree, the last result being about $6\frac{3}{4}$ cubic feet less than the former. This difference, as well as the more trifling difference between the results of the calculations in Articles 50 and 51, might have been avoided, if I had thought proper to use either more places of duodecimals, or more of decimals, than two, in order to make the lineal dimensions, upon which those calculations are founded, to agree more nearly with each other: but this would have defeated the object I had in view, which was to compare the duodecimal method, as it is now actually used, with the new decimal method, as it would be used, in practice; for in like manner as lineal measurements, now made by the former with a view to obtain solid content, are never encumbered by more than two places of duodecimals, in reference to the foot as the unit; so those made by the latter, if hereafter adopted, would never contain more than two places of decimals, in reference to the same unit.

(72) *Second Example, by the Duodecimal System in common use.*

To calculate the cubic content of an excavation measuring 487 feet 9 inches in length, 37 feet 6 inches in mean width, and 19 feet 3 inches in depth.

	Ft.	In.		Ft.	In.		Ft.	In.
	487	9	×	37	6	×	19	3
	37	6						
(a)	27	9						
	3409							
	1461							
	18046	9						
(b)	243	10	6					
	18290	7	6					
	19	3						
(c)	11	10	6					
	164610							
	18290							
	347521	10	6					
(d)	4572	7	10	6				

27)352094 6 4 6(13040 Yds. 14 Ft. 6 2ds. 4 3ds. 6 4ths. the Content.

27

82
81

109
108

14

By rejecting fractions of a foot, and giving and taking, the Answer will be 13040 Yds. 15 Ft. Cube.

Extra Calculations to obtain the above.

(a)

Ft.	In.	
37	× 9	
9		
12)333		
27	9	

(b)

	Ft.	In.	In.	
	487	9	× 6	
6 in. = ½	243	10	6	

(c)

	Ft.	2ds.	3ds.
	19	× 7	6
6 2ds. = ½	9	6	
1 2d. 6 3ds. = ¼	2	4	6
	11	10	6

(d)

	Ft.	2ds.	3ds.	In.
	18290	7	6	× 3
3 in. = ¼	4572	7	10	6

In the answer to this question, 15 feet cube were substituted in lieu of the complex remainder 14 cubic feet, 6 duodecimal parts of the second order, 4 of the third, &c., it having been before explained in Article 67, that all fractions of the cubic foot are rejected in a bill for Labourers' work.

(73) *The same Example, by the New Decimal System proposed.*

To calculate the cubic content of an excavation measuring 487·75 feet in length, 37·5 feet in mean width, and 19·25 feet in depth.

Ft.		Ft.		Ft.
487·75	×	37·5	×	19·25
4−¼				
195100				
1219375				
18290·625				
19¼				
457265625				
164615625				
18290625				

Cubic Feet. 352094·53125 Answer.

Rejecting all fractions less than the foot, in Labourers' work, the above would be stated as 352095 cubic feet, and as estimated by the hundred, it would be stated as 3520 hundreds and 95 cubic feet.

(74) In this calculation, to illustrate what I before asserted that halves and quarters combine well with decimal numbers, instead of multiplying by 375 which is equivalent to 3¾, I have multiplied by 4 minus ¼, and instead of multiplying by 19·25 I have multiplied by 19¼, both of which arrangements save trouble and figures, whilst they bring out the same results, as would be obtained by the longer process.

In this last example, the quantity of cubic feet obtained by both methods is equal, as the lineal dimensions in feet and parts of the foot exactly agree, whether stated in duodecimals or decimals, without exceeding two places of either.

In this as well as in the former example, I may again repeat, that the duodecimal method not only requires more figures, including the little extra calculations marked (*a*)

(*b*) and (*c*), but also a good deal of extra calculation performed mentally: and upon the whole it is in all cases more troublesome, difficult and liable to error, than the decimal method of working out the same calculations.

(75) I before remarked, that the same erroneous system before noticed, in treating of superficial measure, prevails also in solid measure, of calling the twelfth part of the cubic foot the inch cube, which would naturally be understood as implying one cubic inch, when in reality it means 144 cubic inches. This misapplication of terms, together with the difficulty of comprehending the nature of the various products obtained by the multiplication of feet into inches, inches into inches, &c. &c., and the reason for classing them in a peculiar manner, are scarcely ever explained to youth, and for a good reason, namely that many of those who teach do not understand those niceties themselves. Hence the duodecimal Arithmetic of our English Artificers, which is in fact totally different from the common Arithmetic of numbers, being applicable to calculations made by the foot, inch and parts of the inch, and to nothing else, is to young beginners by far the most puzzling part of our national Arithmetic, which even in all its other branches is exceedingly perplexing; and has been rendered so, chiefly by the complexity of our Measures and Weights. These have unfortunately been made the basis of almost all the practical questions in our English School Books of Arithmetic, and by Authors desirous of showing their own ingenuity, and of exercising that of their pupils, have frequently been applied to cases, which never did nor ever possibly can occur, in the real business of life. Hence a considerable part of the contents of these books consists of a set of useless enigmas, calculated either to waste that time and talent, which might be better employed, or to disgust the youthful mind altogether, not merely with common Arithmetic, but with the higher branches of Mathematics, to which its principles lead.

(76) To return from this digression, which however is intimately connected with the subject of this Treatise, if any of my readers should entertain a doubt, as to the disadvantages of the duodecimal compared with the decimal system of calculation, which now have both been under discussion, let him select any practical questions similar to those which I have given in Articles 50 and 51, 68 and 69, 72 and 73, relating either to superficial or cubic measurement; and let him first calculate the area, or cubic content, by

the duodecimal method now in common use in this country; and in order to prove his work, let him perform the same calculation by the same method a second and if necessary a third time, and so on, leaving off whenever he obtains two products exactly alike, at which period, I suppose that he may be satisfied of the correctness of these two, and let him note the time he occupies in this process by a seconds' watch.

Secondly, let him calculate the same question by the decimal method, and let him also in this case perform his work a second, and if necessary a third time, and so on, until he obtains two products exactly alike; and let him likewise note the time occupied by him in this second process.

Admitting the person who tries this experiment, to be equally expert at both of these methods, and to make no error either in the duodecimal or in the decimal calculation, he will find by a reference to the time employed in each, that the decimal method requires only from about one half to one third of the time of the other: but if he be not a very accurate calculator, he will find the superiority of the decimal method still more striking; for the chances are, that he may have to perform his duodecimal calculation three, four, or five times over, before he obtains any two products exactly alike; whereas he may obtain two of his decimal products alike, after the second or third trial at the utmost.

It was by this process, that I satisfied myself of the vast superiority of the decimal over the duodecimal system of calculation, as applied to the measurements under consideration; and no other method of deciding this question can be so conclusive as the system now suggested, namely, that the same individual shall work against himself by time, which is evidently a much fairer mode of trying the experiment, than to calculate against another person.

(77) The expert measurers of artificers' work, to whom I have before alluded, have so many rules for facilitating the duodecimal system of calculation, which by the practice of years they are able to apply without hesitation, to the various cases which may occur, that they become from long habit, insensible of the disadvantages of this method; and such persons will calculate as quickly, or nearly as quickly by duodecimals, as persons not practised in such measurements can do by decimals. But if the same expeditious calculators, to whom I allude, had commenced in early life

by the decimal system, I am confident, that they would then have that very strong impression of the highly superior advantages of the decimal method, which every person, who has not been a measurer of artificer's work from his infancy, will be ready to admit, that this simple method possesses over the complex and embarrassing duodecimal system.

In fact the chief advantage of the decimal system of measurement now suggested by me is its extreme simplicity. Easily learned and understood, for it depends on common multiplication alone, there are not above three or four cases, in which a decimal calculation either of superficial or of solid measure can be abbreviated, by departing from the exclusive use of this rule, which is one of the simplest fundamental rules of Arithmetic. This renders it much less liable to error than the duodecimal system, which as I said before is unintelligible to the young Arithmetician, who learns it merely by rote; the abbreviation of which depends upon a multiplicity of short methods, a specimen of one of which is given in the mode of multiplying by 409 in Article 68; and the perfect mastery of the whole of which cannot be attained, but by the practice of years devoted exclusively to this kind of measurement and calculation.

(78) Although perhaps it may appear superfluous for me to enter into such a question, I cannot close my observations on this subject, without explaining, that my objections to the duodecimal divisions of the foot and inch arise solely from the great inconvenience, which is experienced in calculations of the nature before described, from the mixture of duodecimal fractions with common numbers, the latter of which are founded on the decimal system, of which 10 and the powers of 10 are the elements. In short decimals and duodecimals cannot work well together, although each of them is good separately; so that in order to facilitate calculations relating to measurements &c., one of the two must be used exclusively, to the rejection of the other. But as I have just observed, common numbers, by which I mean all integral numbers, are expressed by the decimal system, which has been adopted for that purpose by all the nations of the world: and from this system they cannot possibly depart to adopt the duodecimal scale of numbers, of which 12 and the powers of 12 are the elements, without an alteration of the whole of those words in their respective languages, by which every number greater than ten is at present expressed. This might not be by any means embarrassing to good Mathematicians, but it would occasion

so much confusion and perplexity to the mass of mankind, that they would never consent to such an immense and overwhelming change; although I admit, that if the duodecimal system of numbers could once be generally established, it would be much more convenient than either the present decimal system, or any other that could possibly be adopted; for the superior advantages of the duodecimal scale, which struck me most forcibly, as soon as I obtained sufficient knowledge of Arithmetic to be able to form an opinion, have I believe been generally acknowledged by the most eminent Mathematicians; or at least by the great majority of those writers who have investigated the theory of Numbers, and especially by the late Professor John Playfair of Edinburgh, who appears to me to have demonstrated them in the clearest and most convincing manner.*

(79) In respect to the suggestion of entirely abolishing the cubic yard, and of adopting the hundred cubic feet in lieu of it, as the highest denomination of measures of solidity, it may be observed that sand, and other materials hitherto measured by the cubic yard, may in future be most conveniently measured by the ten cubic feet; the hundred itself being much too large for a measure, although for very cheap articles it may be the most eligible unit of price. The ten-cubic-feet measure may be made in the form of an oblong case, 2 feet and a half long, 2 feet wide, and 2 feet high; or for greater conveniency, it may be made in two parts, each only one foot high, one to be applied over the other for measuring 10 feet, but to be used singly for measuring 5 feet at a time. In addition to these, a one cubic foot measure should also be provided for measuring still smaller quantities, if necessary. The whole to be open at top and bottom, but to rest on a level piece of ground, or on a wooden platform.

(80) Used in this manner, the ten-cubic-feet measure may perhaps be considered rather to belong to measures of capacity than of solidity. But properly speaking, there is no real difference between these two; inasmuch as the precise value of any measure of capacity can only be known, by estimating it in terms of the unit of measures of solidity. Indeed the Ancient Romans, from whom the measures of Modern Europe were generally derived, used the same unit for both; and the entire separation of the two in this, and in other countries, has been gradually introduced by a devia-

* In a paper, first published in 1807, as an Article in the Edinburgh Review, upon the measurements of an arc of the meridian, between the parallels of Dunkirk and Barcelona, made by Messrs. Mechain and Delambre, by order of the French Government.

tion from the Roman system, which is to be lamented, rather than commended.*

(81) The new system suggested in this and in the preceding Articles, of measuring all Artificers' work and Labourers' work, by the foot and its decimal parts and multiples exclusively, will save more trouble to Architects, Engineers, Builders, and Clerks of Works, as well as to the multifarious Workmen employed under their directions, than words can express: and it will at the same time diminish in proportion, the risk of errors in estimates as well as in measurements, which cannot be made in works of any magnitude, without great prejudice to one of the parties concerned, and in Government Works to the Public. If such measurements were of small importance or rarely required, improvement would comparatively be of less consequence, but they constitute the daily employment of thousands of individuals, and involve the disbursement of immense sums of money.

OF THE PRESENT STATUTE ENGLISH MEASURES OF CAPACITY.

(82) These are divided into four classes, two of dry, and two of liquid measure, in three of which the imperial gallon measure, of 277 cubic inches and 274 thousandth parts of a cubic inch, is the common unit; whilst of the remaining class, the same gallon measure heaped above the rim, so as to increase its value by about one fourth part, is the unit: and in all, the parts of the gallon are now supposed to be alike or proportional, whilst the multiples only are different.

(83) *First. Of Dry Measure stricken.*

4 Gills	1 Pint.
2 Pints	1 Quart.
2 Quarts	1 Pottle or Quartern.
2 Pottles or Quarterns	1 Gallon.
2 Gallons	1 Peck.
4 Pecks, or 8 Gallons	1 Bushel.
2 Bushels	1 Strike.
2 Strikes	1 Coomb.
2 Coombs, or 8 Bushels	1 Quarter.
4 Quarters	1 Chaldron.
1½ Chaldron	1 Wey or Load.
2 Weys or Loads	1 Last.

* The Romans measured large quantities of wine and other liquors by the Amphora, which was exactly one cubic foot, and smaller quantities by the Congius, which was one eighth part of the cubic foot. The Modius of corn was one third part of the Quadrantal, another term for the cubic foot, not so usually applied to liquids. As the Roman was smaller than the English foot, the modius is somewhat less than the fourth part of an English bushel. Consequently it is a gross error to teach boys to translate the word modii into bushels, as is generally done in Latin schools.

This measure is used for seeds, corn, &c. and as the measure is stricken, by a cylindrical or sometimes by a flat wooden Ruler, moved along the brim, after being filled, no part of its contents stands higher than the top of the vessel.

(84) *Secondly. Of Dry Measure heaped.*

2 Pints	1 Quart.
2 Quarts	1 Pottle.
2 Pottles	1 Gallon.
2 Gallons	1 Peck.
4 Pecks, or 8 Gallons	1 Bushel.
3 Bushels	1 Sack.
9 Bushels	1 Vat.
12 Sacks, or 4 Vats	1 Chaldron.
5¼ Chaldrons	1 Score.

In respect to the vessels used as standards of dry measure heaped, it is directed they shall all be cylinders having their diameters double of their respective depths, and that the goods measured thereby shall be heaped up in the form of a cone, to a height at least equal to three fourths of the depth of the vessel, the exterior diameter of which is to be the base of the cone. The only dimensions however specified by law, in addition to the above general rule, are the external diameter of the bushel of heaped measure, which has been fixed at 19 inches and a half, and the height of the cone or heaped part of the same bushel, which is not to be less than 6 inches.

(85) Heaped measure is directed to be used for coals, culm, lime, fish, fruit, and other goods commonly sold by this system in England, excepting that by a more recent law, the sale of the two first articles coals and culm, otherwise than by weight, has been prohibited, in the District comprehending the Cities of London and Westminster, the Port of London, that is all parts of the Thames between Staines Bridge and the Mouth of Yantlet Creek in the Isle of Grain, and every part of the Country in the neighbourhood of the Metropolis, which is within twenty five miles of the General Post Office.

(86) *Thirdly. Of Beer Measure.*

2 half Pints	1 Pint.
2 Pints	1 Quart.
4 Quarts	1 Gallon.
9 Gallons	1 Firkin.
2 Firkins, or 18 Gallons	1 Kilderkin.
2 Kilderkins or 36 Gallons.	1 Barrel.
1½ Barrel, or 54 Gallons	1 Hogshead.
2 Barrels, or 72 Gallons	1 Puncheon.
3 Barrels, or 108 Gallons.	1 Butt.

(87) *Fourthly. Of Wine Measure, also used for Oil and Spirits.*

4 Gills, or Quarterns	1	Pint.
2 Pints	1	Quart.
4 Quarts	1	Gallon.
9 Gallons	1	Anker.
2 Ankers, or 18 Gallons	1	Runlet.
42 Gallons	1	Tierce.
63 Gallons	1	Hogshead.
2 Tierces, or 84 Gallons	1	Puncheon.*
2 Hogsheads, or 3 Tierces, or 126 Gallons	1	Pipe or Butt.
2 Pipes, or 3 Puncheons, or 252 Gallons	1	Tun.

(88) Of the above most complex, and perplexing system of measures, which formerly were rendered still more embarrassing by there having been three gallons in use; namely the wine gallon of 231 cubic inches for wine and spirits; the Winchester gallon of 268·8 cubic inches, or sometimes estimated at 272 or at 272·25 cubic inches, for strange to say, all of those three values were equally legal; and the beer gallon of 282 cubic inches for ale and beer; and which system was also rendered still more complicated by an Act of Parliament, declaring that the coal bushel should contain one quart more than the Winchester bushel, I cannot but observe, how very much the confusion is increased by the useless multiplicity of names, which no person in common life can possibly remember. In respect to dry measure in particular, which stands first on the above list, the smaller denominations are only known to Market Gardeners, and Green Grocers, the greater ones partly to Farmers, and partly to Corn Dealers; but the whole are known to nobody, unless to the school boy, who has just learned them as a revolting task, to be forgotten as soon as he gets out of common Arithmetic into a higher branch of study. Any person might learn and easily remember, that eight gallons make a bushel, and eight bushels a quarter of corn; but what can be more perplexing than the other multifarious terms, uselessly applied to the binary parts and multiples of the bushel? If the Genius of Confusion had presided over the names of such measures, they could not have been more confounding. When a man speaks to me of half a gallon, of 2 gallons, of 2 or of 4 bushels, of 4 or of 5 or of 10 quarters of corn, I can comprehend him; but when he expresses the very same measures to me, as pottles, or quarterns,

* Also called a Tertian in the old English Statutes respecting Wine Measure.

pecks, strikes, coombs, chaldrons, weys or lasts, I have no more idea of what he means, than if he were speaking to me of the measures used in building the Tower of Babel, of the confusion of languages of which period, the above nomenclature presents a lively image.

(89) In comparing those measures together, the application of the terms quartern, quart and quarter, all meaning a fourth part but of different quantities, is remarkable, the quartern of spirits (or gill) the fourth part of a pint, being the thirty-second part of a gallon, the quartern of corn or fourth part of a peck, which is the usual feed of a horse being half a gallon, the quart being the fourth part of a gallon, and the quarter of corn, or fourth part of a chaldron of corn, being equal to 64 gallons.

(90) In respect to Coals and other articles classed with them in the second Table, nothing can be more absurd, than the mode of measuring them by heaped measure, which although essentially different from stricken measure, is expressed by the same terms; and in reference to the term *Chaldron* in particular, as applied to heaped measure, one cannot but be struck with the inconsistency of making a chaldron of coals consist of 36 heaped bushels, which is equal to about 45 stricken bushels, whilst the chaldron of corn is only equal to 32 stricken bushels.

(91) In reality the present heaped measure of England, although authorized by law, does not deserve the name of measure at all, for every intelligent person who has looked into the practice of such measurements knows, that the expert Coal Meter is able, just as it suits his views, to make a difference of 3 or 4 bushels in a chaldron of coals;* and the same difference of quantity may be produced in measuring any other commodity by the heaped bushel, which the dexterous dealer may make more or less as he pleases, without offending the letter of the law.

* Five chaldrons of coals were sent to me for the public service in 1829, by a Coal Merchant of Chatham, who neglected to send a person to measure them, on delivery, as he ought to have done. Being measured with great care by the Clerk of Works employed under me, who would have received them if correct, he reported that there was a deficiency of no less than 16 bushels, being at the rate of more than 3 bushels in each chaldron. When the Merchant afterwards sent a Coal-Meter, who remeasured them in the presence of the Clerk of Works, and myself, by the same bushel measure which we had before used, this man contrived to measure to within 3 bushels of the proper quantity. Thus there was a difference of 13 bushels between the two measurements, and although I considered that of the Clerk of Works to be most correct, I could not reasonably object to the Coal-Meter's mode of proceeding. If we had not been strict with him, I am persuaded that he could have made out much more than the full quantity of 5 chaldrons.

(92) In respect to Beer and Wine Measure, as compared together, two inconsistencies appear, first that different names such as firkin and anker, or kilderkin and runlet, should signify the same quantities of those liquors; and secondly that the same terms, hogshead, puncheon, and butt, as applied to the one should denote different quantities of the other.

(93) In itself, however, and without reference to wine measure, our present beer measure is no further objectionable, than that it evidently would have been more convenient to have regulated it, not by a firkin of 9 gallons, and by the multiples of 9, such as barrels and casks of 18, 36, 54, 72 and 108 gallons, but by a firkin of 10 gallons, and by the multiples of 10, such as 20, 30, 40, 50 and 100; but as it will be seen hereafter that I propose to abolish the gallon measure altogether, I shall pursue this investigation no further.

(94) It may be remarked, that our ale and beer measure was so far simplified about thirty years ago, that the legal firkin of ale, and the legal firkin of other kinds of beer, which formerly differed, were made equal; and the legal barrels of beer, which had one value in London and another in the country, were also equalized. Indeed it may be remarked, that over legislation has been a great evil in all our national measures and weights; but in none more than in respect to casks and barrels. The contents of the barrel of every kind of commodity, usually packed in barrels, of beer, of ale, of herrings, of salmon, of gunpowder, &c. &c. were all fixed by law, and all were different, whether as estimated by the gallon measure or by the pound weight.

(95) Nothing can be worse than this system of making the same word barrel mean a dozen different quantities, as applied to different commodities, which no person in common life can properly recollect. The expressions barrel of beer or barrel of gunpowder, when mentioned to persons who are not in the habit of buying beer or using gunpowder by the barrel, may mean any thing; but if barrels and all other casks were defined, as they ought to be by specifying also weight or quantity, no such mystery or ambiguity would occur. For example, if it were the custom to say a 9 gallon, an 18 gallon, or a 36 gallon cask of beer, instead of using the terms firkin, kilderkin and barrel, which are indefinite to all but Brewers; and if it were in like manner the custom to say a 90 lb. barrel of gunpowder, instead of using the term barrel without further specification, which is inde-

finite to all but Ordnance Officers; there could be neither doubt nor mistake nor ignorance as to quantity.

(96) As all malt liquors used in this country, as well as the casks which contain them, are articles of home manufacture, and regulated by our own laws; the present firkin, kilderkin, barrel and other beer casks, of which the names appear in the Table of our national beer measure, Article 86, are as good measures of quantity as can reasonably be expected; that is not perfectly correct, but sufficiently so for practical purposes. Indeed from the very nature of casks, it is impossible that they can be very correct measures of quantity, although the Coopers of every country, where beer, wine, or spirits are made, take the greatest pains to equalize the dimensions, and consequently the capacity, of all casks of the same denomination and description, as well as to make the larger and the smaller casks, correct multiples and parts of each other.

(97) In this delicate task they succeed perhaps better than could reasonably be expected. The beer butts of the English Coopers, which are purposely made capable of holding one gallon more than the standard of 108 gallons, by desire of the Brewers, who wish to give full measure to their customers, scarcely ever differ more than half a gallon from each other. Foreign casks are generally accurate to within about one per cent of the average content of each kind. For example, in looking over a Wine Merchant's book, in which the size of a great number of pipes of wine, imported from the Island of Teneriffe were recorded, and which were shipped quite full, I observed that about three-fourths of the whole measured 100 imperial gallons, whilst the remaining fourth measured 101 imperial gallons, with the exception of a very few, which measured 99 or 102 imperial gallons.

(98) In respect to the legal Wine Measure of England, as stated in the Table given in Article 87, which declares that the hogshead of wine shall be equal to 63 gallons, the pipe of wine to 126 gallons, and the tun of wine to 252 gallons, fixing the values of the contents of other wine casks being aliquot parts of the above tun in like proportions; and which, without any simultaneous alteration in the casks of the various wine countries, has always confirmed the same numeral values of each in gallons, even when the English wine gallon itself has been materially altered; this system is not only obsolete, but may be pronounced to be perfectly absurd; inasmuch as the hogsheads of the different kinds of

wine imported into this country, all and each of which were fixed at 63 gallons by one of our most ancient statutes, which contrary to all principles of common sense still remains unrepealed, vary from about 44 to 60 gallons of our present imperial measure, and the pipes of the same, which were then fixed at 126 gallons, vary from about 89 to 120 gallons of our present imperial measure.

(99) What was particularly absurd, at some periods of our history, penalties were attached by law to persons, importing hogsheads, pipes, or other casks of wine, not corresponding with the standard hogshead of 63 English gallons, and its multiples or parts; and thus the Parliaments of England attempted to attach to the various wine casks of the world, no two of which of different wine countries were intended to be alike, the same precise values in terms of their own gallon, although until very lately they were unable even to prevent the English wine gallon itself from changing, which for some time after the Norman Conquest, could not have exceeded three-fourths of our present imperial gallon.

(100) At other times, the absurdity of this law caused it to be relaxed, and the duties on wine, although still priced by the tun of 252 gallons, were levied according to the actual quantity contained in each cask, which was found by gaging it when imported; and as we can scarcely suppose that one cask in a hundred, of the wine imported into this country, agreed with those arbitrary values of 252, 126, and 63 gallons, fixed for the tun, pipe and hogshead by the laws of England; this arrangement only caused the same unnecessary difficulties in the calculation of the amount of duty on every cask of wine, which the use of that absurd measure the superficial rod occasions in the calculation of the value of brickwork, as noticed in Articles 56 and 57.

(101) Recently, the system of pricing the duties on every kind of wine by the tun has been discontinued, and by the last law on this subject all those duties are priced by the gallon. In consequence of this more judicious arrangement, the imaginary hogshead of 63 gallons, the imaginary pipe of 126 gallons, and the imaginary tun of 252 gallons have ceased to give trouble either to the Revenue Officers or to the Wine Merchants of this country. Every cask of wine on being imported is measured by a Government Gager and by a Merchant's Gager, in concert, the one acting as a check upon the other, and the duty is charged to the merchant, according to the number of integral gallons of wine

contained in it, as determined by those two Gagers, without noticing any fraction of a gallon however large. The Merchant in his turn charges his customer also for the actual number of integral gallons, which every cask contains, not at so much per gallon, but at so much for the standard or average pipe of each quality of wine in which he deals.*

(102) I am informed that the present standard gages or average contents of the pipe or equivalent cask or casks, of each wine country, in imperial gallons, may be estimated as follows.

Description of Wine.	Imperial Gallons.
Hock, Rhenish, or Moselle, in 4 Aums or Quarter Casks of 30 gallons	120
Lisbon Pipe	117
Port ditto	115
Sherry Butt	108
Malaga Pipe	105
Tent, in 2 Hogsheads of 52 Gallons	104
Teneriffe Pipe	100
Sicilian Ditto	93
Claret, and other French Wines, in 2 Hogsheads of 46 Gallons	92
Madeira Pipe	92
Fayal ditto	89

(103) The Oil Casks termed Butts or Pipes, &c. &c. varied still more from the imaginary standards of 126 gallons, &c. &c. to which they also had been subjected by the same impracticable laws, as will be seen by the following Table, in which their respective capacities are stated.†

* As an example of the present practice of the Wine Trade of this Country, if we suppose that a Pipe of Port Wine on being gaged is found to contain 112 Imperial Gallons, the Duty would be charged as follows.

	£.	s.	d.
112 Gallons, Duty at 5s. 6d. per Gallon	30	16	0

The price might be charged by the Merchant to the Purchaser of the Wine as follows.

	£.	s.	d.
112 Gallons of Port Wine, at £84. per Pipe of 115 Gallons	81	16	2

It is known that every cask of wine loses. A pipe is said usually to lose about a gallon more or less according to the length of the voyage, before it is landed in England; and it is calculated that it afterwards loses about one gallon per annum in the cellar, where it is kept. These losses as well as the interest of the capital expended in the purchase of the cask, are made good to the Merchant, by his being enabled to charge old wine at a higher price than new.

† These are extracted from the Book of Instructions for the Gagers in the several Ports of the United Kingdom, printed by authority in 1826.

Whale Oil Casks.

	Imperial Gallons.
Large Butt	332
Small Butt	223
Long Pipe	118
Common Pipe	98
Breakers of different sizes	83
	55
	40

Olive Oil Casks.

Gallipoli	Butt	201
	Pipe, large	139
Genoa Butt		130
Gallipoli Pipe, small		106
Genoa Pipe		102
Gallipoli	Short Puncheon	100
	Short Cask	62
	Hogshead	53

I forbear to state the average capacity of the several hogsheads, and other casks, in which spirits are usually imported into England, it being sufficient to say, that these also differ from each other, although bearing the same name, as well as from the supposed legal value of the hogshead, &c.

(104) It is proper to observe, in discussing this part of our subject, that if our ancestors had always imported one kind of wine only from some wine country, of which the tun, pipe, and hogshead, had measured 252, 126, and 63 English gallons on an average, there would have been no great inconvenience and no impropriety, in making those the legal standards of our national wine measure: but as it is extremely improbable, that the English ever confined themselves to one kind of wine exclusively, and as the generality of our ancient Kings and their advisers, however deficient in science or literature, were not wanting in natural talent; I am unwilling to suppose that the ancient law alluded to was originally founded, on such gross and glaring error, and entire ignorance of commercial affairs, as the inforcement of it in the present times would evince. I conceive on the contrary, that it may have been well considered and not injudicious at first; but that by degrees having become obsolete, its original meaning was lost and forgotten, after which the literal interpretation of it became absurd.

(105) This opinion I found on the following considerations. First, that the wine gallon of England was de-

clared by our most ancient laws, to be a measure capable of containing 8 pounds weight of that liquor. Secondly, that no doubt the English ton weight, which is now measured by twenty hundred weight of 112 pounds each, must originally, like the ton weight of France before the French Revolution, have been measured by exactly twenty hundred pounds, or 2000 pounds weight.

If therefore we suppose, that the ton weight and the tun of wine were intended to be identical, by the ancient laws of England, which is extremely probable, the latter may have originally contained 2000 pounds weight or 250 gallons of wine, and therefore the pipe of wine may have contained 125 gallons, and the hogshead of wine 62 gallons and a half,* and as all our other measures of capacity, as well as all our weights, are known to have increased more or less, in the course of four or five centuries after the Norman conquest; I conceive that the standard hogshead of wine may also have increased, but in a more moderate degree, from 62½ to 63 gallons, in order to avoid a fraction, and that this increase of the hogshead must have led to the proportional increase in the standard pipe and tun.

(106) But whatever may have been the origin of the statutes alluded to, they have entirely ceased to be acted upon, the wine trade of this country, and the business of the revenue depending on it, being now conducted on the more rational principles explained in Article 100. Hence it is perfectly ridiculous, as our Elementary Books on Arithmetic still do, to teach error to youth, on the authority of those obsolete laws, which through an oversight of the legislature have not yet formally been repealed, by assigning to all the discordant wine casks of the world, the same common fixed values in English measure, when in reality they have none.†

* About the time that those laws were enacted, there is reason to believe, that not only the English and French monetary systems, but also their weights and consequently their respective tons were nearly alike: and at the same period or soon after, the Kings of England were masters of Guienne, and had therefore the power of legislating also for that particular district of France, which probably supplied the greater part of the wine imported into England. In statute 1, of the 5th of Richard the Second chap. iv, regulating the prices of different wines, the wine of Gascoine is first mentioned, after which the wines of Rochel, Osey, and lastly the wines of Spain and of the Rhine are enumerated. It is to be presumed that those wines, which were the most used in England, were placed the first in order, in the above list: and I consider it more than probable, that the tun, hogshead, &c. of Bordeaux at that time agreed with the English standard.

† It is remarkable, that in no common Table of English Measures, that I have ever seen, is this circumstance noticed, excepting in the Almanac of the Society for the Diffusion of Useful Knowledge, which I have before mentioned in Article 15, as being free from another ridiculous error, in respect to our national measures of length.

(107) Having premised so much, I beg leave to suggest, as an effectual means of further simplifying the above chaos, for our national system of measures of capacity, even in its present improved state and practice, deserves no other name, that heaped measure shall be entirely abolished; and that the new cubic foot shall be the element of all our measures of capacity, dry as well as liquid; the adoption of which will be attended with the most important advantages, inasmuch as it will give a precision to our ideas of quantities of goods or of liquors, sold by measure, from which by our present system of measures of capacity, we are altogether excluded, unless we have recourse to very troublesome calculations. The cubic foot is, in fact, the only clear and intelligible standard of measures of capacity. Every man can understand the nature of a quantity, that is stated as being capable of filling a space, one foot in length, one foot in width, and one foot in depth; but when a quantity is stated in gallons of 277·274 cubic inches, in bushels of 2218·192 cubic inches, or in the various other multiples of the gallon, all of which are fractional, in reference both to cubic inches and cubic feet; and when these statements are farther embroiled by the distinction between stricken and heaped measure; it is absolutely impossible to form any correct notion of the space required, to contain a given quantity of goods, or of liquor, so stated.

(108) It may be remarked, that the objects of measurements of capacity are not of a permanent, but generally of a perishable nature, such as corn, seeds, and fruit, wine, and other liquors, which after being once measured are consumed, without being subject to any remeasurement, excepting for the purposes of retail. Hence new quantities of these objects are always the subject of new measurements, without any reference to former measurements. Accordingly no possible inconvenience or confusion can arise, from measuring them one year by the imperial gallon or bushel, and the next by the cubic foot. Indeed a great advantage will result from doing away the bushel, which although by Act of Parliament declared to consist of 8 imperial gallons, had until that Act was passed, a different value in almost every county of England and Wales, so that in those counties in particular, in which the bushel of 8 gallons had not before been used, the act for uniformity of measures must have caused great confusion, in all transactions between retail dealers and their customers.

(109) As an example of this, so late as the year 1824, when the changes alluded to were ordered to take place; the bushel of Bedfordshire was 2 pints above the standard of 8 gallons, the bushel of corn in some parts of Berkshire was 9 gallons, the bushel of Cornwall was 24 gallons, the bushel of hemp seed in Dorsetshire was 9 gallons; the bushel of corn in some parts of Durham was five per cent above the eight gallons; in other parts it was equal to 8½ gallons. The bushel of Gloucestershire varied from 9 to 9½ and 10 gallons. The bushel of barley, beans and oats, at Liverpool was 9 gallons: the bushel of grain in Leicestershire varied from 8½ to 9 gallons, the bushel of malt in the same county being 8 gallons. The bushel of wheat in Oxfordshire was 9 gallons 3 pints: the bushel of barley, peas, and wheat in Shropshire was from 9½ to 10 gallons: at Wolverhampton in Staffordshire the bushel was 9½ gallons: in Westmoreland the bushel was 24 Winchester gallons; but at Appleby in the same county, the bushel of barley was 20 gallons, and the bushel of potatoes 16 gallons. In Worcestershire the bushel was 8½ gallons, at Worcester 9, at Evesham, and in some parts from 9 to 9¼. In Brecknockshire, the bushel was 10 gallons: in Monmouthshire from 10 to 10½ and nearly 11 gallons; in Montgomeryshire 20 gallons. At Welshpool in the same county, the bushel of malt was 18 gallons, and the bushel of oats 35 gallons heaped. At Fishguard the bushel was equal to 16 Winchester gallons. In some parts of Radnorshire, the Winchester bushel was used: in other parts a bushel of 10 gallons.

The above specimen of the utter confusion of measures, that prevailed in England, previously to the Act for establishing the Imperial Weights and Measures in 1824, has been extracted from the Appendix to the Second Report of the Commissioners on Weights and Measures;* but to add to the difficulty, in many places, the bushel of various kinds of grain was estimated by weight; and the precise weights required to constitute one bushel of the same kind of grain varied in various counties, in the most irregular proportions.

(110) Such being the case, it will perhaps be admitted, that the simplest and most expeditious and effectual method, of putting an end to the above perplexing mass of confusion, would have been to have abolished the term bushel altogether, which had a different signification in almost every district. The introduction of the imperial gallon and

* Ordered by the House of Commons to be printed on the 18th Sept. 1820. In the same Document the customary measures of Scotland are also noticed, which were perhaps still more irregular than the above.

bushel was certainly attended with the greatest advantages, to the inhabitants of the metropolis and its environs, who had always used a bushel of 8 gallons: but to a man of Cornwall, who had been accustomed to call 24 gallons a bushel, the law that required him to call one-third of that quantity in future by the same denomination, must have been equally perplexing, as if an Act of Parliament had passed to compel him to call the number one hundred, in future by the term one dozen, and vice versa. And in all those counties, where the bushel was measured by more than 8 gallons, the like confusion of ideas must have been caused more or less, by the introduction of the imperial measure. If on the contrary, the cubic foot had been introduced, it is impossible that any confusion of ideas could have been occasioned thereby, for the same English foot is used in all parts of the United Kingdom, with no further deviation from the correct standard, than may be occasioned by inferior workmanship, which I have never observed to amount to more than about one part in four hundred of the whole length, and generally in excess. Such being the case, the cubic foot, which I now propose as the unit of measures of capacity, is the only new measure of this description, that can be adopted without inconvenience or confusion; and as the people of those counties of England and Wales, who were accustomed to the multifarious bushels before mentioned, are still in their prime, having only used the imperial bushel for about seven years, the sooner the cubic foot is introduced the better; for nothing else can remove the difficulties, with which the change from their original measures to the imperial bushel, must necessarily have puzzled and confounded the present generation of men in those counties.

(111) It may be remarked, that when it was first proposed to establish one gallon instead of three or four,* it was the declared opinion of the Royal Commissioners appointed to report upon these subjects, that a gallon capable of containing exactly ten pounds avoirdupois of distilled water at the temperature of 56½ degrees of Fahrenheit, and with the barometer standing at 30 inches, would measure precisely 276·48 cubic inches of our standard lineal measure, and consequently that 100 such gallons would be exactly equal to 16 cubic feet. This last coincidence was held out by Doctor Wollaston and Professor Playfair, when examined on this subject before the House of Commons, as being the

* Besides the corn gallon, beer gallon, and wine gallon, there appears to have been a mash-tun gallon, all of which differed from each other. See the first Editions of Symons' Practical Gager, published before the present imperial gallon was introduced.

chief advantage of adopting ten pounds of distilled water for the standard value of the gallon. Unfortunately it was afterwards found, by more accurate experiments and observations tried by Captain Kater, one of the above Commissioners acting by their authority, that these two coincidences could not take place together; and the latter which was so highly appreciated by Professor Playfair, was made to give way to the former, so that as I before implied in Article 107, it is absolutely impossible to reduce a quantity stated in imperial gallons into cubic feet or inches, or vice versa, by any simple arithmetical process; the calculations necessary for effecting these reductions, being embroiled with such very aukward fractions, as render them extremely troublesome, and literally make it impossible for the mind, to form any just notion of the comparative value of these two incongruous measures, the imperial gallon and the standard cubic foot.

(112) The calculations of Revenue Officers are rendered exceedingly intricate from this cause. They have however adopted a very judicious system of measuring exclusively by inches and decimal parts of an inch, rejecting the lineal foot, which would not only give unnecessary trouble by continual reductions, from feet and inches into inches, and vice versa; but would also lead to confusion, by that intermixture of duodecimal and decimal fractions, which I have already reprobated. After having obtained the content of a cask or of any other vessel which it is their duty to gage, in cubic inches and decimal parts, they have to reduce it into gallons or bushels; and here the inconvenience of such aukward fractional divisors as 277·274 and 2218·192, is strongly felt.*

(113) The same difficulty embarrasses the Engineers and Architects, who are to supply cities or houses with water. After considering how many gallons shall be allowed daily to each house or family of a certain number of persons, when in reference to this proportion, they proceed to determine the dimensions of their water pipes, and reservoirs, they must have recourse to feet and parts of the foot; and consequently in addition to the aukward multiplier

* Instead of dividing by these aukward divisors 277·274 and 2218·192, they sometimes multiply by their decimal reciprocals ·003607 and ·000451, which afford the means of reducing cubic inches into gallons or bushels with sufficient accuracy and with less trouble; for long Multiplication is an easier process, and less liable to error than long Division. Whilst investigating this subject, I was induced to look into a book entitled the Practical Gager, &c. by Wm. Symons, formerly a Collector of Excise, and was much pleased with the modes of measurement of the Revenue Officers of this country as therein stated, in which much ingenuity has been displayed, to obviate as far as possible, the difficulties arising from the complex nature of our national measures.

277·274 which they must make use of, in order to convert the given number of gallons into cubic inches, they must divide the product by 1728, or three times successively by 12, in order to reduce the latter into cubic feet, which causes a great deal of trouble and confusion, and may even occasionally lead to error.

To illustrate these observations, a couple of practical questions shall be annexed.

(114) ***First, relating to the Measurements of Revenue Officers.***

A cask of Sherry Wine having been gaged at 14,928·72 cubic inches, how many imperial gallons does it contain?

277·274)14928·72(53·84 Gallons. Answer.
13863 70
1065020
831822
2331980
2218192
1137880
1109096
28784

In charging the duty, the above quantity would only be reckoned as 53 gallons, although it approaches much nearer to 54, the custom being to exclude all fractions, as before noticed. This custom would also save some figures in the above calculation; but would not altogether remedy the inconveniences of so very complex a system.

Second Example, relating to the Business of Civil Engineers.

A Reservoir capable of containing 375,984 gallons of water being required to be constructed, how many cubic feet must it measure, in order to hold the above quantity?

375984
277·274
1503936
2631888
751968
2631888
2631888
751968
104250587·616 Cubic Inches.

12)104250587·616 brought over.

12)8687548·968

12)723962·414

Answer 60330·201 Cubic Feet.

(115) In respect to the above questions it will be allowed, that on merely hearing the contents of a cask of wine stated at about 14,929 cubic inches, no person could say off hand, that this quantity was nearly equal to 54 imperial wine gallons; and in like manner on hearing that a reservoir was to hold 375,984 gallons of water, no person could say off hand, that it ought to measure 60,330 cubic feet nearly. These values are absolutely not to be obtained without the foregoing calculations.

By the adoption of the cubic foot proposed by me, as the common unit of measures of solidity and of capacity, all this trouble will be saved, for the measurements of Revenue Officers and the calculations of Engineers would then be made, in reference to one and the same simple measure, the new foot and its decimal parts; and no reduction between such very incongruous measures, as the present gallon and its multiples, and the present cubic foot and its parts, would ever be required.

(116) If on the contrary the present system of making the gallon the unit of liquid, and the bushel that of dry measure, shall be retained, no other simplification or improvement, that can possibly be adopted in our national measures of capacity, and there is great room for both, can ever render them intelligible. For the same remark before made in Article 12, in respect to present statute lineal measure, and in Article 41, in respect to our present statute land measure, not only now applies, but will continue to apply also to these two standards. When we hear of any number of gallons, such as 5375, or of any number of bushels of corn such as 7153, we can form no more notion of the space which either of those quantities would occupy, than of the space that would be required to contain 5375 Ephahs of ancient Jewish measure, or 7153 Attic Medimni. And what is more, if accurate Tables of Ancient Measures were as common as Tables of our own, we would be able to find out the value of the Ephahs or of the Medimni, with quite as much facility as that of the gallons or the bushels, since it is impossible that the former calculation can be more complex than the latter. A reference to Tables in both cases would be necessary, because with the exception of Engineers, Revenue Officers, and Schoolmasters, there is not

one man in a thousand of the population of the British Islands, who knows how many cubic inches there are either in the imperial gallon or bushel, it being impossible, even for those who have known them once, to remember such very complex fractional expressions, as 277·274 and 2218·192, for any length of time.

(117) In further illustration of the incongruous nature of our present statute measures of capacity and of solidity, which are perfectly incommensurate, although if the dictates of reason alone had determined such matters, they ought to have been identical; I shall annex a General Table of all the denominations forming our present corn measure, coal or heaped measure, beer measure and wine measure, extracted from the former Tables of those respective measures, classed in regular order from the smallest measure upwards, and showing the space occupied by each; in which the Reader will observe the great inequality of several measures bearing the same name, and the extreme complexity and confusion of the whole.

GENERAL TABLE OF THE PRESENT STATUTE ENGLISH MEASURES OF CAPACITY, DRY AND LIQUID, SHOWING THE VALUE OF EACH, IN CUBIC INCHES, AS WELL AS IN CUBIC FEET, OF THE PRESENT STANDARD.

	Cubic Inches.	Cubic Feet.
1 Gill stricken, or liquid, or 1 Quartern applied to liquids only	8·6648	0·005
1 Half Pint stricken or liquid	17·3296	0·01
1 Pint stricken or liquid	34·6592	0·0201
1 Pint heaped	43·992	0·0255
1 Quart stricken or liquid	69·3185	0·0401
1 Quart heaped	87·984	0·0509
1 Pottle stricken, or 1 Quartern stricken applied to corn only	138·637	0·0802
1 Gallon stricken or liquid	277·274	0·1605
1 Gallon heaped	351·936	0·2037
1 Peck of Corn, &c. stricken	554·548	0·3209
1 Peck of Coals, &c. heaped	703·872	0·4073
1 Bushel of Corn stricken	2,218·192	1·2837
1 Firkin of Beer, or 1 Anker of Wine or Spirits	2,495·466	1·4441
1 Bushel of Coals, &c. heaped	2,815·489	1·6293
1 Strike of Corn stricken	4,436·384	2·5673
1 Kilderkin of Beer, or 1 Runlet of Wine or Spirits	4,990·932	2·8883

	Cubic Inches.	Cubic Feet.
1 Sack of Coals, &c. heaped.....	8,446·466	4·888
1 Coomb of Corn stricken	8,872·768	5·1347
1 Barrel of Beer	9,981·864	5·7765
1 Tierce of Wine	11,645·508	6·7393
1 Hogshead of Beer.....	14,972·796	8·6648
1 Hogshead of Wine.....	17,468·262	10·1089
1 Quarter of Corn stricken	17,745·536	10·2694
1 Puncheon of Beer	19,963·728	11·5531
1 Puncheon of Wine.....	23,291·016	13·4786
1 Vat of Coals, &c. heaped	25,339·398	14·664
1 Butt of Beer	29,945·592	17·3296
1 Pipe or Butt of Wine	34,936·524	20·2179
1 Tun of Wine	69,873·048	40·4358
1 Chaldron of Corn stricken	70,982·144	41·0776
1 Wey of Corn ditto.....	88,727·68	51·347
1 Chaldron of Coals, &c. heaped..	101,357·593	58·656
1 Last of Corn stricken	177,455·36	102·6941
1 Score of Coals heaped	532,127·364	307·9441

(118) Comparing the new foot proposed by me with the present English foot, and considering that it has been declared, that the imperial gallon of 277·274 cubic inches of our present measure, contains exactly 10 pounds avoirdupois of distilled water, I calculate that the new cubic foot measure will contain a weight of 64·706567 pounds avoirdupois. Now as the enlightened Members, both of the recent Parliamentary Committees and of the Royal Commission, on the subject of Weights and Measures, have declared their opinion, that the standard measure of capacity in any country ought to contain, and is best determined by, some given weight of distilled water, and that this weight ought to be an integral not a fractional number of pounds; in deference to such high authority, I beg leave to propose a new pound, which shall weigh exactly one sixty-fifth part of the weight of distilled water, contained in the new cubic foot measure. But as we have not yet finished the subject of measures of capacity, I shall abstain from making any farther observations upon the new pound, for the present.

(119) Impressed with the very great advantages which would attend the adoption of the new cubic foot, as the sole unit of measures of capacity, I was pleased to find, on endeavouring to accommodate it as far as possible to our present measures of that description, that the imperial pint and quart were very nearly exact aliquot parts, and that the

imperial quarter of corn, was very nearly equal to 10 such cubic feet, or an exact multiple, of it. Hence all these denominations, modified a little to suit this important unit, may still be retained, and used as at present. Nothing can be more fortunate than these coincidences.

(120) In respect to the gallon, the same facility does not exist, it being impossible to obtain any gallon that shall be an aliquot part of the proposed cubic foot, without either making so great an increase or diminution, as would be a total change and not a modification of the present gallon. For example, one sixth of the proposed cubic foot would be too large, as it would yield a gallon of nearly 300 cubic inches, which would exceed not only the present imperial gallon, but even the old beer gallon of 282 cubic inches, more than is desirable. On the other hand, one seventh part of the cubic foot would be too small, as it would yield a gallon of only about 256 cubic inches, and the adoption of it would not only be disagreeable to the working classes, who would naturally object to a diminution of any measure, but it might even be prejudicial to them for a certain time; because if the gallon were reduced in the manner supposed, it is not probable that beer would be sold cheaper in consequence, in the first instance; for according to the present price of London Porter, the difference would only amount to about two-thirds of a farthing; and every one knows, that it is the custom of Tradesmen to keep to themselves all fractions of a farthing, which in the just balance of any payment ought to belong to their customers; nor is it perhaps unreasonable that they should do so, as there is no smaller coin current in this country. Besides which, the seventh part of any measure of capacity would be the most inconvenient of all aliquot parts that could be adopted, as the number 7 has no factors or aliquot parts of its own, or in other words it cannot be divided exactly by any other number, without a remainder.

To pursue this inquiry a little farther, the eighth part of the proposed cubic foot would form a gallon of rather more than 224 cubic inches, which was the legal wine gallon of England in the reign of Queen Elizabeth, and which would in many respects be a very convenient measure: but I conceive that the feeling of the people would be so very strong, against the adoption of a gallon, so much smaller than they have lately been accustomed to, that they could never be reconciled to the change. Hence as the gallon cannot by any modification or moderate change be made an aliquot

part of the cubic foot, it appears to me that it will be much better to reject it altogether, than to apply that denomination to a new measure widely differing from it, for it may be allowed that in measures which must be used daily by the mass of the people, nothing is likely to cause more confusion, than to apply an old name, to which a precise value has been attached, to denote a new quantity.

(121) It being necessary, however, to have some intermediate measure between the cubic foot and the quart, as a substitute for the gallon, nothing seems more convenient than the tenth part of the cubic foot, which will be exactly equal to five pints, or to two quarts and a half. This new measure I propose to call the "Can," a word which conveys to the mind the idea of about two or three of our present quarts, and which is therefore appropriate to the quantity intended, but which having never before been applied to any precise quantity, in this country, cannot after being once defined, lead to ambiguity or confusion.

(122) By this arrangement the cubic foot of 1000 cubic digits, will be divided into 10 cans, 25 quarts, 50 pints; and 100 half pints; and if it should be judged desirable, that the half pint, as being an important decimal part of the cubic foot, should have a distinct name, it might be called the "Chopin," a word which although obsolete in England, has always been used to designate the half pint measure, both in France and in Scotland. But I do not urge the adoption of this term, which I merely throw out as matter of consideration.

The new pint and the new quart, thus proposed, will respectively exceed the present imperial pint and quart, by about one part in twenty-nine, which will scarcely make a difference of a quarter of a common wine glass between the two pints, and of half a wine glass between the two quarts. The new quarter of corn proposed will also exceed the present imperial measure of that name, but in the smaller proportion of one part in ninety one, so that the new will only contain about two quarts and a half more, than the present imperial quarter of corn. The above differences between the present and the proposed measure, both being in moderate excess, and in favour of the new measure, will not offend any popular prejudices; nor create any temporary inconvenience to the mass of the people, who in any change of measures of the same denomination, always applaud an increase and object to a diminution; although it must be allowed that after a little time, it can make no pos-

sible difference to them, whether the new measure be greater or smaller than the old, for in the long run, the prices of all commodities sold by measure must necessarily depend on real and not on nominal quantity.

(123) It is proper to observe, that the reduction of the proposed new cubic feet into quarts, and of quarts into cubic feet, may be performed in a much easier manner, than by the common method of multiplying or dividing by 25. In reducing cubic feet into quarts for example, add two zeros to the given number of feet, and divide by 4; and vice versa in reducing quarts into cubic feet, strike off two places of decimals from the given number of quarts, and multiply by four.

A couple of questions calculated both ways are subjoined, to show the superior facility of this simple method.

Example first. To reduce 137 cubic feet into the new quarts of 25 to the cubic foot.

By the Common Method.	*By Abbreviation.*
137 Cubic Feet.	4)13700
25	
685	Answer 3425 Quarts.
274	
Answer 3425 Quarts.	

Example second. To reduce 183775 of the new quarts into cubic feet.

By the Common Method.	*By Abbreviation.*
25)183775(7351 Cubic Feet	1837·75
175 Answer	4
87	Answer 7351 Cubic Ft.
75	
127	
125	
25	
25	
..	

In like manner cans may be reduced into quarts by adding one zero, and dividing by 4, instead of multiplying by the mixed number $2\frac{1}{2}$ or its decimal equivalent 2·5; and quarts may be reduced into cans, by striking off one decimal

place and multiplying by 4, instead of dividing by $2\frac{1}{2}$, or by 2 5.

Example first. To reduce 314 cans into quarts of $2\frac{1}{2}$ to the can.

By the Common Method.

314
$2\frac{1}{2}$
628
157
Answer 785 Quarts.

By Abbreviation.

4)3140
Answer 785 Quarts.

Example second. To reduce 3578 quarts into cans.

By the Common Method.

$2\frac{1}{2}$)3578
2
5)7156
Answer $1431\frac{1}{5}$ Cans.

By Abbreviation.

357·8
4
Answer 1431·2 Cans.

These answers are alike, the one-fifth part, or the two-tenths of the can, which are the remainders of those two methods, being each equal to eight cubic digits.

(124) However simple and obvious this method of dividing or multiplying any number by 4, in order to obtain the results of the multiplication or division of the same number by 25, or by $2\frac{1}{2}$, may appear to an Arithmetician, it is not generally taught in English schools, or school books; and therefore, I thought it right to introduce it in order to prove, that the reduction of cubic feet into quarts, or of cans into quarts, and vice versa, are nearly as easy as the reduction of pence into farthings, and of farthings into pence; and this facility is of the greatest importance, in reference to our present subject, for if decimal parts and multiples, which are the simplest of all cannot be used, in every detail of a system of measures and weights, it is desirable, that those which approach the nearest to them in simplicity, should be adopted.

(125) Having now fully explained the objections to our present measures of capacity, as well as the principle according to which it is proposed to improve them, the following scale is suggested for that important purpose.

PROPOSED NEW TABLE OF MEASURES OF CAPACITY.

For Retail Dealings, exclusively.

2 Gills, or 10 Cubic Digits.....1 Half Pint.
2 Half Pints or Chopins .....1 Pint.
2 Pints .....1 Quart.
2½ Quarts, or 5 Pints .....1 Can.

For Wholesale Dealings.

100 Cubic Digits .....1 Can.
10 Cans, or 1000 Cubic Digits.....1 Cubic Foot.
10 Cubic Feet .....1 Quarter of Corn.

The new cubic foot is to contain exactly 65 pounds weight of distilled water, when the temperature is at 18 degrees of the centesimal thermometer, and with the barometer standing at 24½ digits of the new lineal measure suggested.

I propose hereafter to treat of measures of temperature. In the mean time, it may be proper to explain, that the above temperature and state of air agree with 62 degrees and 4 tenths of a degree of Fahrenheit's thermometer, and with the barometer standing at 29 inches and 77 hundreth parts of an inch nearly of our present measure.

(126) By the above arrangement, whilst we return to the judicious system of the ancient Romans, by making the cubic foot the unit of all our measures of capacity as well as of solidity, which is by far the most simple, intelligible and convenient, that can be adopted for that purpose; we will deviate so little from our present customs, that beer and spirits will still continue to be retailed by the quart, pint, and gill; and corn to be sold in wholesale by the quarter, with no other difference than the proposed new division of this quantity into 10 cubic feet, instead of 8 bushels.

The only difference in the retailing of beer will be the disuse of the gallon measure, which can cause no possible inconvenience, as the person who wishes to purchase more than two quarts at a time, has only to specify the particular number of quarts he desires, if it should not agree with an integral number of cans.

(127) In the retail of corn, the disuse of the gallon and peck, will require quantities, less than one cubic foot, to be stated in cans or in quarts. For example, the feed of a horse may be two quarts, or three quarters of a can of oats, and his ration for one day, if allowed four feeds, may either be 8 quarts, or 3 cans, the former of which allowances differs from the latter by about one fifteenth part in excess.

(128) In the wholesale of beer, the present brewers' casks agree very well with the new measures proposed; for as the present firkin of 9 gallons, which is the unit of beer-cask measure, if I may use the expression, is very nearly equal to 14 cans, which it exceeds by a trifling fraction; the half firkin, firkin, kilderkin, barrel, hogshead, puncheon, and butt, now in use, will be respectivcly equal to about 7, 14, 28, 56, 84, 112, and 168 cans of the new measure proposed.

(129) Agreeably however to the principle alluded to in Article 93, in case of the adoption of the new system of measures of capacity proposed, the Brewers should be required, as soon as their present casks shall be worn out, to provide themselves with a set of barrels and casks, each containing an integral number of tens of cans, or of cubic feet, for which the following scale may be convenient, namely casks of 10, 20, 30, 40, 70, 100, and 150 cans respectively; or of 1, 2, 3, 4, 7, 10, and 15 cubic feet, which are the same quantities differently expressed. I conceive it probable that these gradations will suit all the wants of private houses, in proportion to the number of persons in each family, and of public houses in proportion to their custom, it being well known that a quick draught, or consumption of beer, is essential to prevent it from becoming vapid; and therefore publicans, having little or moderate business, order their beer in barrels or puncheons, whilst those on a greater scale order it in butts. As beer measure may be regulated by our own laws, it will be better in describing beer casks by their contents, to state quantities in cubic feet than in cans; and I would also recommend that all kinds of beer shall be priced by the cubic foot, instead of the present discordant system of the English Brewers, which is to price table beer by the gallon, and strong beer by the barrel of 36 gallons.*

(130) Instead of the above scale of beer barrels and casks, any other may be adopted, if deemed more convenient. But in the event of the new measures of capacity being hereafter established by law, it will perhaps be best to permit the Brewers, to send out their beer in any sized barrels or casks they please, provided only that every such vessel shall contain an integral number of cubic feet. In this case, the practice of the Trade will soon accommodate itself, in some simple and convenient manner, to the wants of the public.

* This system must evidently have arisen, from the circumstance that the tax on beer, recently abolished, was levied by the barrel.

(131) In respect to the various wines imported into this country, the following may be adopted as the standard gages of the pipe or butt of each, in cans as well as in cubic feet of the new measure, in which all fractions smaller than the can are avoided, according to the present custom of the wine trade.

Description of Wine.

	Cans.	Cubic Feet.
Hock, Rhenish, or Moselle, in 4 Aums or Quarter Casks of 47 Cans	188	18·8
Lisbon Pipe	180	18
Port ditto	178	17·8
Sherry Butt.....	166	16·6
Malaga Pipe	162	16·2
Tent, in 2 Hogsheads of 80 Cans	160	16
Teneriffe Pipe.....	154	15·4
Sicilian Ditto	144	14·4
Claret and other French Wines, in 2 Hogsheads of 72 Cans	144	14·4
Madeira Pipe.....	142	14·2
Fayal ditto.....	138	13·8

(132) In adopting the new system of measures proposed, the duty on Wine would be levied either by the can, or by the cubic foot, as might be judged best. It will be evident from inspecting the above table, that either of these quantities will be equally convenient, but it is probable that the Revenue Officers of this Country would give the preference to the can, as being the nearest approximation to the gallon, by which they have hitherto been accustomed to gage all casks of wine.

(133) In respect to retail dealings in wine, bottled beer and spirits, which are always sold by the bottle or by the dozen of bottles, I would recommend no other change, than selling by the ten bottles instead of the twelve. The new measures will agree very well with the present practice, for the new cubic foot will contain nearly 40 wine bottles, and the can will contain nearly 4 wine bottles of the usual size, which are improperly termed quart bottles, although only averaging three quarters of a quart each; for the present imperial gallon contains about 6 of these bottles.

USEFUL APPROXIMATIONS BETWEEN THE PRESENT AND THE NEW MEASURES OF CAPACITY PROPOSED.

(134) The new quart will be to the present imperial quart as 30 to 29 nearly; and the new pint and new gill

will be to the present imperial pint and imperial gill respectively in the same proportion. (Article 122.)

The new measure the Can, the tenth part of the proposed new cubic foot, will be to the present imperial gallon as 9 to 14, or more nearly as 11 to 17. The last proportion is so very nearly accurate, that it will not make a difference of more than the third part of a cubic inch in defect, in reducing the contents of a Butt of Sherry from imperial gallons into cans.

The new cubic foot will be to the present cubic foot as 27 to 26 nearly.

The new cubic foot will be to the present stricken imperial bushel as 1 to $1\frac{1}{4}$, or as 4 to 5 nearly.

The new quarter of corn will be to the present imperial quarter of corn as 92 to 91 nearly. (Article 122.)

The new cubic foot will be to the present heaped imperial bushel, as 1 to 1 and 6 tenths, or as 5 to 8 nearly.

Fifty six cubic feet and a half of the new measure will differ from the present chaldron of coals by so very small a fraction in excess, that the two quantities may be considered identical.

It must be understood, that these last proportions, between the cubic foot and the present heaped bushel, and its multiple the chaldron, refer not to heaped measure, as it actually is in practice, but as it ought to be, according to theory; for we must never lose sight of the truth before stated, that heaped measure is so uncertain, that it does not deserve the name of measure at all.

(135) As the sole object of measures and weights is to afford a correct estimate of quantity, in order that the proportional values of goods of the same quality may be priced justly; it will not be irrelevant to the object of this treatise, to enquire into the practice of the dealers in corn, coals, &c. who sell in some parts of the United Kingdom by measure and in others by weight; with a view to decide, how far both of these methods may be allowed, as being equally correct and convenient, or whether one of them may not be more accurate than the other.

REMARKS ON THE PRESENT SYSTEM OF MEASURING CORN IN ENGLAND. THAT IT MAY BE MEASURED IN MASSES OF ONE QUARTER OR TEN CUBIC FEET AT A TIME, WHEN IT IS TO BE STOWED AWAY IN BULK. THAT THE MEASUREMENT OF CORN DOES NOT AFFORD SO JUST AN ESTIMATE OF QUANTITY, AS ITS WEIGHT.

(136) In measuring corn in England, the system is to measure lightly as it is termed, by pouring it gently into the bushel measure, or by entering the measure itself into a loose heap of corn so as partially to fill it, and then completing the filling of it by the hands; and afterwards by passing the strike, or wooden ruler, along the top of the measure, when a little more than full, in order to scrape off the superfluous parts. By our ancient laws, it was illegal not only to require more than 8 bushels to the quarter of corn, which appears to have been a common practice, but even to shake the bushel in measuring corn, which process compresses it into a smaller space, and therefore requires a greater quantity to fill the same measure. These statutes were enacted in the feudal ages, when rents were paid partly in kind, to protect the vassals, who were obliged to deliver a certain number of bushels of corn to their Lords at stated times, from being harshly dealt with, by having compressed instead of loose measure exacted from them.

It is therefore to be understood, that in stating the weight of a sample of corn, per bushel, the measure is always supposed to be filled lightly, as above described, and the quality and price are regulated in proportion to weight and measure thus combined. Wheat is said to vary in weight from 55 to 65 pounds avoirdupois per bushel. Rye from 51 to 58. Barley from 46 to 51. Oats from 36 to 44. Peas from 61 to 69. Small beans from 61 to 68. Seeds also vary in weight according to their quality.

(137) In experiments recently tried upon the measurement of corn at Chatham,* we found that neither wheat nor oats varied more, when measured lightly and carefully by the bushel, than half a pound between the highest and the lowest values of each measure, the average weight of the bushel of wheat experimented with being 64 pounds, and that of the bushel of oats 40 pounds avoirdupois, as ascertained by repeated measurements, and weighings of the contents of the bushel measure: the extremes thus differing from each other, one part in 128 only or about $\frac{3}{4}$ per cent in wheat, and 1 part in 80 only or $\frac{1}{2}$ per cent in oats.

* By Captain Young of the Royal Engineers and me, in December, 1832.

Afterwards we measured both the wheat and oats in masses of 16 cubic feet, in a large rectangular box, made for the purpose, four feet high, and having a square base measuring 4 superficial feet, in the clear. In two measurements of the oats, the first required 523 pounds weight to fill the box, being at the rate of 32 pounds 11 ounces to the cubic foot: whilst in the second trial 522¼ pounds filled the same space. In filling the measure with the wheat, exactly 806 pounds weight were required in two successive trials, being at the rate of 50 pounds 6 ounces of wheat to the cubic foot. In these measurements, we noticed particularly the difference of weight between the lowest or most compressed foot in height, and the uppermost or least compressed foot in height, of the corn in the box, which difference was about 2½ lbs. in the oats, and 3 lbs. in the wheat, being only a variation of 2 per cent in the former, and of 1½ per cent in the latter.

(138) Such being the case, I beg leave to recommend, when corn is to be measured and sent off in bulk, which is usually done in the loading of vessels, or barges, that it shall not be served out by one or two cubic feet at a time, according to the present system of measuring in detail; but that it shall be measured by the 10 cubic feet measure, the contents of which are exactly one quarter of corn of the new system proposed, and the depth of which being only two feet, is too moderate to cause the lower part of the mass of corn to be perceptibly compressed in the measure. But as this measure, which was before described in Article 79, is proposed to be made in two parts, each capable of being used separately, any corn dealer may if he pleases serve out his corn by the half quarter or 5 cubic feet measure, in which it will only stand one foot high.

(139) When corn is to be carried off in sacks of the usual size, each of which contains 4 of our present bushels, and consequently 5 of the new cubic feet proposed, the contents of each sack may either be determined by the half quarter or 5 cubic feet measure, just mentioned; or the proper quantity of corn may be served out and poured into every sack, by means of a cylindrical cubic foot measure, exactly 1 foot deep, and as nearly 1 foot and 128 one-thousandth parts of a foot as possible in diameter, in the clear; which will be equally convenient with the present corn bushel generally used in the country, from its shape called the drum bushel, the exterior diameter of which is about 13½ inches, and more so than the shallower corn bushel, the exterior diameter of which is 19½ inches. The latter is also the legal coal bushel, and the only one proper for heaped mea-

sure; but it requires two men to lift it, and empty its contents into a sack, in consequence of its inconveniently large diameter, whereas the former can be managed by one man.

(140) Notwithstanding the conveniency, and the degree of accuracy, with which corn may be measured lightly; it must be confessed, that weight offers a much more accurate mode of estimating quantities of corn, than the most correct measurements practicable: especially as we also ascertained by experiment, that a difference of nearly 2 lbs. may be made in a bushel, either of wheat or of oats, by measuring them heavily, as the Corn-dealers express it, that is either by throwing the grain in forcibly, or by pressing it in with the hands, or by shaking the measure. We found that a like increase took place in the quantity necessary for filling the 16-cubic-feet box, when the corn was thrown down forcibly into it from a height. And upon the whole, we concluded, that a Labourer employed in the measurement of corn, who wished to favour the purchaser, might, by measuring heavily, make a difference of 2 or 3 per cent in wheat, and of from 3 to 5 per cent in oats, to the prejudice of the seller of the corn.

(141) Wheat being round and smooth, runs almost like dry sand, and is therefore not liable to be compressed more than has been mentioned, without breaking the grain, but oats being of a more pointed and irregular form, and having a husk attached to the grain, may be compressed much more than the above proportion. We found, for example, that nearly 47 pounds of oats might be forced into a bushel measure, which 40 filled when measured lightly: and we also found, on ramming in the oats with a wooden rammer, which did not break the grains, that 606 pounds could be forced into the experimental box before described, which was filled with 523 pounds when measured lightly.

(142) Hence, although the usual system of measuring corn in England, is sufficiently accurate, when done honestly and carefully by one person, yet it must be allowed to be liable to uncertainty, when done by different persons, or by the same person negligently or partially; and this uncertainty is absolutely irremediable, for the purchaser cannot legally object to light measure if the bushel be filled; and the seller cannot in decency object to a man measuring heavily, if he does it expeditiously, and without any unusual or apparent effort, such as pressing the corn forcibly in with his hands, or perceptibly shaking the measure. The system of weighing, on the contrary, being absolutely free from all uncer-

tainty, is by far the fairest mode, that can possibly be adopted in the sale of corn, and this operation may also be performed somewhat more expeditiously than that of measuring; although the latter need not be complained of, as I am informed that 10 quarters, or 80 bushels of corn, may be measured in an hour, by expert labourers.

(143) In some parts of England corn is sold by weight, but by a curious and most complex arrangement, a certain arbitrary weight is called a bushel: which weight not only varies for different kinds of grain in the same town, county or district, but also varies for the same kind of grain in different districts. For example, if 62 pounds be assumed for the bushel of wheat, in any of those districts, the Farmer does not measure his corn at all, but weighs 496 pounds, and calls this quantity 8 bushels, or 1 quarter of wheat, and charges it at so much per bushel or per quarter, to the person who buys it. This mode of estimating quantity is to be reprobated, as adding to the confusion of our national measures and weights, which are already too complex, by uselessly introducing a fictitious bushel of uncertain value, into transactions depending upon weight alone. It is, however, when once understood, a fair mode of dealing between man and man.

At Liverpool corn as well as flour are always priced and sold by weight alone, it being of course understood, that in examining several samples of the same grain, the specific gravity of the corn, or its weight per bushel, is previously considered, in fixing the price of each: and it is remarkable with how much accuracy experienced Farmers or Corn-dealers can judge of the specific gravity of any kind of grain, by merely taking up and poising a small quantity of it in their hands.

It is to be hoped, that the Liverpool system of pricing corn by weight, which has also invariably been acted upon by Government in their purchase of oats for the British cavalry, and which has I believe been partially adopted even in private dealings by some Corn-merchants of London, will be made universal throughout the whole British Empire.*

(144) In adopting this arrangement, the only thing necessary will be to fill the present corn sack with so many pounds weight of each kind of grain, as are usually contained in four bushels of medium quality measured lightly, taking care

* Oats are sent from the Ordnance Military Depôt in Tooley Street, to the West Indies, for the public Service, in sugar hogsheads containing exactly 1000 lbs. weight each. They are entirely priced by weight, but none are received, which weigh less than 40 lbs. to the bushel, when measured rather lightly. This is a very simple and good arrangement.

however that each quantity shall be a multiple of 10, not embarrassed by units of pounds. For example, the contents of the sack might conveniently be made 260 lbs. of peas or small beans, 240 lbs. of wheat, 220 lbs. of rye, 200 lbs. of barley, and 160 lbs. of oats, respectively: and every kind of grain should, according to its quality, be priced by the 100 lbs. weight, and not as at present by the fictitious bushel,* or by the conventional hundred weight of 112 lbs., the entire abolition of which most inconvenient multiple of the commercial pound will hereafter be recommended.

THAT COALS SHOULD NOT BE SOLD BY MEASUREMENT, BUT BY WEIGHT, AS THE FORMER DOES NOT AFFORD A JUST ESTIMATE OF QUANTITY.

(145) In treating of the heaped measure of this country as established by law, by which coals are sold, I before observed that the expert Coal-meter, in measuring out coals by the single bushel at a time, according to custom, can, if he pleases, make a difference of no less than 3 or 4 bushels in a chaldron, to the prejudice of the purchaser. This remark applies to coals of the same quality, and of the same average size; but if two masses of coals of the same quality be of very unequal size, the uncertainty of this our present legal mode of measurement by the heaped bushel is so much increased, that the objections to it ought in justice to amount to entire prohibition.

(146) The reason of the very great uncertainty, which may occur in estimating the same identical quantity of coal, or of any other solid body, by measurement, after breaking it from large into small, may appear obvious on a little reflection: but the extraordinary degree, to which the difference in apparent quantity may be carried from this cause, could not be anticipated, and perhaps would scarcely be credited, without having recourse to actual experiments.

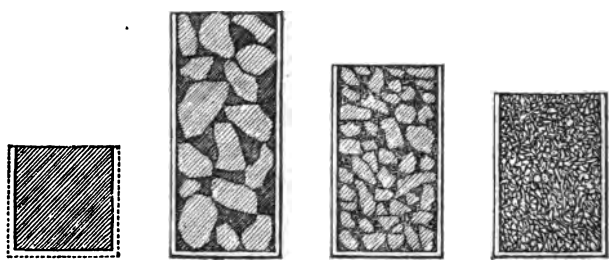
(147) For example, in the annexed diagrams, (Page 74) let Fig. 1, represent a piece of coal, lime, or other breakable solid, fashioned into the form of a cube, which we shall suppose to measure 1 cubic foot. On breaking it by a hammer into

* In the Liverpool Market, oats are priced by the 45 lbs, barley by the 60 lbs, wheat by the 70 lbs, oatmeal by the 240 lbs, flour by the 280 lbs, and Indian corn by the 480 lbs. Probably these discordant quantities, assumed as the units of price for different kinds of grain and meal, may have depended upon the contents of the several packages, in which they have usually been imported into the port of Liverpool. Whether this be the case or not, I consider that the pricing of all grains in future by the 100 lbs, would be the greatest possible improvement upon the above practice.

about 30 pieces, which will necessarily be unequal and irregular, with a small proportion of rubbish and dust, the same quantity will now evidently occupy a larger space, by measurement; because those pieces, which in the common method of measuring coals, lime, &c., are never packed, but thrown in at random, are now separated from each other, and from the sides and bottom of the vessel in various parts, by numerous cavities, which may bear a considerable proportion to the solid parts of the whole mass. Accordingly we found by experiment, that a cubic foot of coal, after being thus broken may occupy more than double its original space by measurement, as represented in Fig. 2, in which the fragments of the block shown in Fig. 1, are supposed to fill two cubic feet and a quarter. Thus supposing a Coal Merchant of the South of England to purchase a quantity of very large coals at Newcastle by measure, he might sell the same as a much greater quantity, by breaking them at his own wharf, before he serves them out to his customers. But it will of course be understood, that this difference would not double the original quantity, as was the case in the above experiment, because the waggons at Newcastle, in which coals were formerly measured out in mass by the North Country chaldron, of rather more than two imperial chaldrons, could never be filled by one single solid coal. The difference in apparent measure between the coals shipped at Newcastle, and sold in the South of England, would therefore probably not exceed from 25 to 30 per cent at the utmost.

(148) This circumstance, although not generally understood by the public, was well known in the trade, and accordingly in the Reports of the Parliamentary Committees on the Coal Trade in 1829 and 1830, which led to the abolition of the sale of coals by measurement in the Metropolis and its vicinity, it is stated as an undoubted fact, that several Masters of Colliers were in the habit of breaking the large coals, shipped by them from Newcastle and Sunderland, before they delivered their cargoes in London, in order to increase their own charge for freightage, which was paid to them on measurement in the Pool, by the imperial chaldron; and it is also stated in the same Reports, that coals were broken smaller and smaller, not only on board ship, but also at the Coal Merchants' wharfs, and in the stores of the Retailers of this article, as they were supposed, after each breakage, continually to increase in apparent measure, to the advantage of the seller and to the prejudice of the purchaser.

(149) Repeated experiments tried by us at Chatham, whilst they proved the fact, that large masses of coal when broken into several pieces, will occupy a much greater space, did not bear out the supposition apparently entertained by several of the evidences before the said Committees, namely, that the apparent magnitude of the same quantity will go on increasing gradually, as they are broken smaller and smaller, until further breakage becomes impossible. For example, after having broken a cubic foot of solid coal into thirty pieces, we did not find any further increase of measure by afterwards breaking them into three hundred. On the contrary these three hundred pieces occupied a smaller space than the thirty had done, for although the number of interstices was multiplied tenfold, they were diminished in magnitude in the same proportion, and the rubbish and dust being also increased, after this second breakage, found its way into the interstices, and partially filled them. Accordingly the cubic foot of solid coal, (Fig. 1) which by breaking it into thirty pieces, had dilated into two cubic feet and a quarter, (Fig.2) was diminished from thence to one cubic foot and three quarters, on being broken into three hundred pieces, as shown in Fig. 3: and finally on pounding these three hundred pieces into rubbish and dust, it was diminished still further to one cubic foot and a half, as shown in Fig. 4.



1 2 3 4

(150) Thus then, I have explained in reference to experiments, which any of my readers may easily verify, how very uncertain the valuation of coals by measure must be, since by gradually breaking from a solid state, which is the minimum of measure, into various sizes, a block of 1 cubic foot may be made to increase in apparent quantity to a certain maximum, and from thence gradually to diminish again in apparent quantity, to an intermediate state between these two extremes. Hence a person who sells coals by measure, may derive an advantage from breaking very large

ones smaller: but this process has a limit, for in a cargo of clean coals freed from dust by screening, in which state they are always shipped at Newcastle and Sunderland, after the largest shall have been broken into pieces not smaller than about the size of a man's fist, and not leaving any larger than three or four times that size, which is perhaps the most saleable state and the most convenient for domestic use, in which coals can be exhibited, a person selling them by measure would be himself the loser by breaking them smaller; for after being thus broken they will measure less than they did before.*

(151) Another circumstance which does not apply to grain or liquids, and which has not hitherto been sufficiently attended to, in considering this subject, pleads very strongly against the sale of coals by measure, namely that large measures and small, although the former may be exact multiples of the latter, yield unequal results, when applied to the measurement of the same quantity, even without any intermediate breakage between the two measurements. A measure capable of containing 10 cubic feet, for example, will hold a greater quantity of coals, lime, &c. than ten times the contents of a cubic foot measure of the same articles, as we found by repeated experiments at Chatham, in which the actual difference of quantity, resulting from these two modes of measuring the same nominal quantity, was not less than 5 per cent. The reason of this apparent inconsistency is, that the interstices or vacant spaces adjoining to the sides and bottom of a small measure, bear a greater proportion to its capacity, than in a large one. Hence in the early periods of the Coal Trade, when quantity was estimated not only in the South but also in the North of

*. If it were the rule in selling coals by measure, that all the intervals between large pieces should be completely filled with rubbish or coal dust, the dealer would invariably gain by breaking large pieces smaller: but this is not the case, as the coals intended for domestic purposes are passed through screens with half inch intervals between the wires, before they are shipped from Newcastle and Sunderland: and in order to make out more measure, the labourers who unload the colliers afterwards, by sending up the coals in successive basketfuls from the hold, take care never to mix the larger pieces with rubbish or dust in the same basketful. A smaller duty was formerly charged on coals capable of passing through a three-eighth inch screen. Hence it became the practice to screen the coals twice at the pit's mouth, through screens only differing one-eighth of an inch from each other, than which it is difficult to conceive any thing more absurd, if partly law and partly the taste of the purchasers had not made it compulsory. At one time the proprietors could get no sale for their small coals at all, so that when they found no persons willing to carry them off gratuitously, they were actually obliged to burn them in masses, which lamentable waste of an article of such immense importance to mankind would probably not have taken place, if coals had been sold by weight and not by measure.

England by measure alone, every waggon measure of coals shipped at Newcastle, and constituting a North Country chaldron according to law, instead of only exceeding the common chaldron of 36 bushels, by the just difference due to the proportional capacity of the two measures, must have measured a great deal more, when delivered in the Pool at London, where the coals were measured by the vat or quarter of the common chaldron; and in like manner, the coals received by the Coal Merchants of London in the Pool, must have measured considerably more, when afterwards served out to the public by the imperial bushel; so much so, that it has been estimated that 13 chaldrons of the Pool measure, by which the coal merchants of London purchased their coals, were equal to 14 chaldrons of the wharf measure by which they sold them,* which was further increased to nearly 14 chaldrons and two thirds, by an allowance of 5 per cent called "Ingrain," which the merchants always received in the purchase of a cargo of coals, or of any part thereof not less than 5 chaldrons.

(152) If this allowance had been granted as a discount upon the price to a wholesale purchaser, it would have been intelligible to the public; but being made out by calling 21 chaldrons 20, that is by charging 210 chaldrons as only 200, it greatly increased the confusion and uncertainty of the coal measure of the Port of London, for the price of coals on the Coal Exchange was always stated by the fictitious chaldron of Pool measure including the ingrain, seven of which fictitious chaldrons were equal to eight chaldrons of wharf measure; and as none but persons belonging to the coal trade were aware of the difference between these two unequal quantities, both being called the chaldron, and both being supposed to be the legal chaldron, the prices of coals at the Coal Exchange, as stated in commercial records, and quoted from time to time in the newspapers, were only calculated to mislead the public. But I shall pursue no further this investigation into the former absurdly complex and uncertain coal measure of the Port of London, now fortunately abolished, which required a host of coal meters, undertakers, basketmen, and coal whippers afloat, and of land coal meters at the wharfs, who being all privileged, or under the control of privileged persons, rendered the unloading of a collier three or four times as expensive as it need have been; for the seamen, whose understood duty it

* See the evidence of John Buddle, Esq. an experienced colliery-viewer, in page 305 of the Report on the state of the Coal Trade, by a Select Committee of the House of Commons, ordered to be printed on the 30th of July 1830.

is to deliver the cargo of a merchantman, either entirely or with a little assistance according to their number, were obliged to stand idle, whilst the London coal whippers were doing that duty at more than double the common wages of labour :* and it is needless to say, that all this prodigal and superfluous expense eventually fell upon the consumers of the coals, uselessly and perniciously enhancing the price of that indispensable article, to the inhabitants of the Metropolis.

(153) I before remarked in Article 90, upon the absurdity of having two different chaldrons, one of corn, the other of coals, which is generally supposed to be the only legal coal measure of that name, in addition to which I must now notice the still greater absurdity, which then escaped my memory, that there is a third chaldron, namely, the Newcastle coal chaldron, which is also a legal chaldron, having been fixed from time to time by laws, which although prior to the establishment of our present imperial measures of capacity, were not repealed on that occasion. In fact, the coal districts of the North of England have their own peculiar system of coal measure, probably of considerable antiquity, which is as follows.

Table of Coal Measure used in Durham and Northumberland.

8	Bolls	1 Fother.
24	Bolls, or 3 Fothers	1 Chaldron.
192	Bolls, or 8 Chaldrons	1 Keel.
420	Bolls, or 17½ Chaldrons	1 Ton.†

Originally the North Country coal chaldron must have been at least equal to 134·4 cubic feet, since the boll, which was the unit of the system, was estimated as being equal to 4½ bushels of Winchester measure. But in the reign of

* These high wages were however of little benefit to the coal whippers, who were not able to procure employment without the intervention of undertakers, chiefly publicans, who forced them to expend the greater part of their earnings in liquor. See Appendix B in page 65 of the Second Report of the Select Committee of the House of Lords on the Coal Trade, ordered to be printed the 19th of July 1830.

† The contents of this gigantic local Ton measure, if estimated by weight, must have averaged nearly 50 tons avoirdupois. It appears to me evidently to have been derived from 20 score of bolls, using the long score of 21 bolls, as customary in wholesale dealings. The Table of Coal Measure, of which it forms a part, was extracted from the evidence of H. Taylor, Esq. colliery agent and coal owner, in the first Report of the Select Committee of the House of Lords on the Coal Trade. See page 78 of that Report, which was ordered to be printed on the 8th of February 1830. I apprehend that Chalder must have been the original and proper name of the North Country Coal Chaldron,

King George the Third, on finding the uncertainty attending the measurement of coals by these waggons, notwithstanding that by law, all those belonging to the same colliery were to be of uniform dimensions and marked by Officers of the Customs, and to be filled level with the top without heaping; it was agreed to receive 53 cwt. of coals, which had long been considered the legal value of the North Country chaldron, by weight independent of measure. Hence the waggon itself ceased to be the measure, being filled no higher than the above weight required; which in coals of the average size usually drawn out of the pit, is said only to occupy about 126 cubic feet.* Thus in passing from measure to weight, the North Country chaldron has been reduced from about 134½ to 126 cnbic feet, and what is curious, it has since then been estimated as equal to two imperial chaldrons, which ought only to occupy a space of about 116 cubic feet. (See the Table in Article 117.)

(154) In the coal trade of the Metropolis, it is said that this proportion very nearly held good, for the 53 hundred-weight, shipped at Newcastle as the North Country chaldron, measured two common chaldrons by the vat of Pool measure in London as nearly as possible, but at most of the outports they measured a great deal more than two common chaldrons, in consequence of using the bushel, because the chaldron deduced from the vat, and the chaldron deduced from the bushel, are in reality different quantities, although declared by law to be the same.

From this error in legislation, arose the ridiculous dilemma, in which the Coal Fitters or Agents of Durham and Northumberland were most unjustly placed. The coals shipped by them were estimated by the North Country chaldron, which after having been declared to be 53 cwt, had become an invariable quantity or nearly so, whereas they were delivered to the Coal Merchants of London, and other ports of England, and the freightage and duties were charged, according to the measure made out by the Coal Meters at the respective ports of delivery, by the common chaldron of 36 bushels, which was a variable quantity. Hence the Coal Fitter, who sent a cargo of 100 North country chaldrons to London, with a certificate stating that quantity as being equal to 200 common legal chaldrons, would

* Instead of loading the colliers from these waggons, at once, which was frequently done, coal barges called keels were also used for the same purpose, which were marked externally, so as to show the displacement of water occasioned by each chaldron of 53 cwt. of coals contained in them. This method affords an accurate estimate of weight. Penalties were attached by law to the altering or falsifying of the marks on the keels.

be considered a fair dealing person, because his coals would measure 200 common chaldrons as delivered by the vat, but if he sent the same cargo with the same certificate to other ports, where the 100 North Country chaldrons would measure from 225 to 240 common chaldrons by the bushel, he might be considered guilty of a fraud, and liable to a fine of 100*l.* for making a false certificate. Accordingly, the experienced Coal Fitter, knowing how much and in what proportion, the measures used at the several outports of the Kingdom differed from each other, although declared by law, and supposed by the public to be identical, was compelled to make out different certificates, in shipping the same quantity of coals for different ports. In short, he was obliged to sign false certificates from time to time, in order to avoid the penalties attached to this very act, by an absurd law, which declared unequal quantities to be equal; and which admitted of no greater variation from the erroneous proportion assumed between quantities, shipped by the Newcastle chaldron, and delivered by the common chaldron, than 5 per cent; whereas the deviation from that proportion, which at London was null, or very trifling, in most other ports of England, averaged from 10 to about 20 per cent in excess.

(155) To exhibit in a clearer light the uncertainty of our present coal measure, which as yet has no where been remedied, except in the Metropolis, it was stated, in a Memorial addressed to the Lords of the Treasury in 1822, by the Coal Fitters of the port of Sunderland, that the Keel of coals, consisting of 8 North Country chaldrons, when delivered at Whitby, Scarborough, Bridlington and London, measured about 16 common chaldrons, which was the supposed correct proportion and value of the North Country coal measure, in the common legal coal measure of England; but that at Plymouth and Bridport, the keel measured a little more than 16 chaldrons; at Weymouth and Exeter, it measured 16½ chaldrons; at Gravesend and Leigh, Dover and Lyme Cob, about 17 chaldrons; at Harwich, Maldon, Emsworth, Chichester, and Dartmouth, about 17½ chaldrons; at Chatham, Sheerness, Newhaven, Portsmouth, Southampton, Cowes and Poole, about 18 chaldrons; at Lynn, 18½; at Wisbech and Boston, 19; and at Ipswich rather more than 19 chaldrons; which last quantity, although exactly equal to the North Country keel in real value, exceeded the legal value of it, erroneously assumed to be correct, by no less than 20 per cent.*

* In this Document, which appears in explanation of the Evidence of Sir Cuthbert Sharp, Collector of the Customs at Sunderland, when examined

(156) Thus there are two causes of the extreme uncertainty of coal measure; first that the same quantity of coals may measure more or less in the same vessel, or measure of capacity, according to the average size of the pieces; secondly that the same quantity of coals in pieces of the same size, will measure more or less in different sized vessels, although belonging to the same standard of measures of capacity; and upon the whole it may be allowed on further consideration of this subject, and in reference to the same data, that the uncertainty of coal measure may be diminished, so far as wholesale dealings are concerned, but that it cannot be entirely removed, by the use of larger measures not heaped. The expert Coal-meter who is now able to make a difference of 3 or 4 bushels in every chaldron, by measuring lightly, will still be able to make a difference in using a much larger measure than the imperial bushel; and coals of the same quality, but of unequal size, will always differ, more or less, in quantity, by the same kind of measurement, although not so much in a large vessel as in a small one. Moreover, the same description of coals thrown into a large measure, with the same degree of force, may, from their irregular form, assume a looser or denser arrangement by accident, in settling down towards the bottom of the vessel, so as to cause a difference of quantity in successive measurements, even without any trickery on the part of the Meter. Finally, the labouring classes of the community will always be obliged to purchase coals, if sold by measure, in very small quantities, and consequently by some very small measure, not exceeding the cubic foot: so that they and their families, who are the least able to afford such a sacrifice, would be supplied with less of that necessary article, in proportion to the money expended by them

in 1829 before the Select Committee of the House of Lords, on the Coal Trade, the Memorialists prayed to be relieved from the difficulties occasioned, by obliging them to ship coals by weight, and to deliver them by a system of measure, which although declared to be the same by law, differed at almost every port in England. Sir Cuthbert Sharp bore testimony to the reasonableness of their Memorial, and the accuracy of their statements. See his Evidence, commencing in Page 23, of the first Report of the above Committee. Mr. G. Chickhen, another evidence before the said Committee, stated that the brig Darlington, commanded by him, and invariably loaded with from 99 to 100 Newcastle chaldrons in sixteen several voyages to London, instead of making out only from 198 to 200 chaldrons of the imperial measure then established, according to the supposed just proportion, measured from 208 to 222 such chaldrons, which great difference of apparent measure in the same real quantity, he ascribes to the judgment or caprice of the various Coal Meters employed. This difference between his statement and that made in the above-mentioned petition, only tends further to prove the extreme uncertainty of coal measure. See page 107 of the Second Report of the above Committee.

in the purchase of it, than the higher or the middling classes, who will be able to order 50 or 100 cubic feet of coals at a time. These considerations combined form the insuperable objection to the sale of coals by measure, which was before alluded to in Article 145.

(157) The sale of coals by weight, on the contrary, affords an accurate test of quantity,* as it is one that cannot be altered, otherwise than by wetting them for the purpose of fraud, in which case the purchaser would of course reject them. Even if completely saturated with wet, we have ascertained by experiment at Chatham, that coals of a marketable quality will not gain more than 4 per cent, and very small coals, such as scarcely would be received by a purchaser, will not gain more than 10 per cent of additional weight. In both cases the coals were kept under water for 72 hours, and in this state they were dripping wet, so that if put into a sack or vessel not water tight, the water would actually have run out. If only moderately wetted, and not in such a state, as absolutely to disgust the purchaser, we found that coals, of good quality and of moderate size, would not gain more than from 1 to 2 per cent of additional weight, a difference altogether insignificant, when compared with the extreme uncertainty of measurement: and we also found that they threw off moisture more quickly, than almost any other solid substance capable of imbibing it.†

* Different sorts of coals bear different prices, some being much superior to others, so that a quantity of the former, whether estimated by measure or by weight, will always sell for more than an equal quantity of the latter. The specific gravities of various kinds of coals were stated to be as follows, in reference to 1,000 the specific gravity of water. That of Cannel coals was said to be from 1,100 to 1,200, so that a solid cubic foot of this kind of coal would weigh from 68¾ to 72 lbs. avoirdupois. That of free burning or bituminous coal varied from 1,250, the average specific gravity of Newcastle coal, to 1,350, so that the cubic foot will vary from 78 to 86 lbs. That of the stone coal from Wales varied from 1,400 to 1,500, so that the cubic foot would vary from 87½ to 93¾ lbs. The lightest kinds of coals are usually the best. See the evidence of David Mushett, Esq. coal proprietor, in page 238, 2nd Report of the Select Committee of the House of Lords.

The weight of the bushel of coals from Newcastle, as purchased in the London market from the average of 22 ships' cargoes, is estimated at 76¾ lbs. by George Lowe, Esq. Superintendent of Gas Works. See page 181 of the same Report. This gentleman states that the coals imported by the Gas Companies themselves, weighed more than the above, the extremes being from 73 or 74 to 84 or 85 lbs, and the average about 79¼ lbs. per bushel.

† The various experiments alluded to, respecting the measurement and weight of coals, were tried partly by Captain Young and me, in the winter of 1831-2, and partly by Mr. Howe and me in the spring of 1833. Excepting in the circumstance stated in Article 150, the results of our experiments perfectly agreed with the statements of the intelligent and experienced Evidences, examined before the Parliamentary Committees on the Coal Trade in 1829-30, whose Reports I had not seen until after these experiments were tried.

(158) Moreover, under all circumstances, coals can be weighed much more expeditiously and easily, than they can be measured, at least by a small measure. In weighing coals as delivered from the ship, one of the scales, suspended from a beam in the usual manner, is fitted up as a coal box, with an upright side and a sloping bottom; and when this scale, which projects beyond the ship's side, preponderates over the other scale, to which weights of two hundred weight and a half, or 280 lbs. of our present avoirdupois weight are attached, the upright side of the box is made to open from below, by undoing a bar; and the coals are shot down the slope into a lighter, or it may be into a cart or waggon alongside of the vessel. In the Thames lighters, coals are stowed away in mass, in the several rooms or compartments, divided from one another by partitions, each of which used to contain 5 or 10 chaldrons, but is now made to contain 7 or 14 tons weight. It becomes necessary therefore to weigh them again in portions of two hundred weight, which has been adopted as a convenient quantity for the contents of the coal sack, which formerly held 3 bushels. In packing them into the sacks from the lighter by weight, a balance is used of the small and portable new construction, which has recently been generally adopted in this country, which consists in fixing the scales by a double beam, to the head of upright pillars, instead of suspending them by a single beam from above, which in weighing coals in a barge, or on a wharf, would require a strong triangle, or other very inconvenient and heavy frame to hang it by. Two Labourers fill the sack with their shovels, whilst a third holds it upright on one scale, the weights being placed on the other. As soon as the coals preponderate, the man who held the sack takes it on his back, the others assisting to lift it, and carries it to the cart or waggon standing on the wharf to be loaded, whilst in the mean time another Labourer is ready with another empty sack, to be filled in the same manner. Thus ten sacks contain a ton weight of coals, and as the same portable kind of balance and scales, with the necessary weights are always sent, as directed by law, with the coal waggon, to which they are fixed in a convenient manner under the body of it, and between the hind wheels; the person, at whose house they are delivered, may easily ascertain, that the weight stated in the Coal-merchant's bill is correct, by causing the men sent with the waggon, to reweigh some or even the whole of the sacks in his presence, which by means of the portable balance and scales, may be

done almost as quickly, as the sacks can be emptied into the vault, without this process. In short nothing can be more satisfactory or more convenient, than the arrangements now adopted in London for the sale of coals by weight, which it appeared proper to describe, for the information of those readers, who may not have had an opportunity of witnessing them; and it is to be hoped that the Legislature, duly appreciating the advantages of this excellent system, will entirely prohibit the sale of coals by measure, not merely in London and its vicinity, but throughout the whole of the British Empire. By so doing, they will put an end to the strong temptation, as well as the great facilities afforded to fraud, by the present legal system of coal measure, which is the most unfavourable to the public and to the fair dealer, that could possibly have been invented.

(159) In proposing to set aside the measurement of coals entirely, it appears to me, that the only improvements upon the system now followed in the Coal Trade of the Metropolis, that can be suggested, would be to enact, first, that coals shall be shipped and delivered, and always priced in wholesale dealings, by the 1000 pounds weight, instead of the Ton of 2240 pounds,* which ought to be abolished for reasons, that will afterwards be stated; and the disuse of the Ton would require the contents of the coal sack, which is now 224 lbs, either to be increased to 250 lbs weight, or to be diminished to 200 lbs weight, as may be deemed most convenient, in order to render the sack an aliquot part of the proposed thousand weight: secondly, that in all retail dealings, coals should be priced by the 100

* The present Form of Invoice or Certificate of a cargo of Coals, shipped at Sunderland for Rochester, is as follows.

Sunderland, April 10th, 1833.

I have shipped on board the Resource of this Port, Mr. Robert Smith Master, one hundred and ninety-six Tons, two hundred weight, of the Hetton Coal Company Lyons Wallsend Coals, per drop, at twenty two shillings and sixpence per chaldron of 53 cwt.

For the Hetton Coal Company,

Custom House, Sunderland, J. Sheville.
10 April, 1833.

Ent^{d} G. Buddle, p. Collector.

Thus the Coal Proprietors state their account of the quantity of coals supplied by them to their correspondent in Rochester, by the ton of 20 cwt, but price them by the North Country chaldron of 53 cwt, whilst the Rochester Coal Merchant, who is still not allowed to receive them without the intervention of a Coal Meter, has them measured by this person according to the common legal chaldron of 36 heaped bushels, by which also he sells them to the public. This is a curious and certainly an unnecessarily complex arrangement, which ought to be simplified by abolishing both the North Country chaldron and the common chaldron,

pounds weight, and not by that very aukward quantity, the conventional hundred weight of 112 pounds, which I before reprobated, in treating of the sale of corn.

THAT LIME OUGHT NOT TO BE SOLD BY WEIGHT, BUT BY MEASUREMENT. OF THE CUSTOMARY METHODS OF MEASURING LIME. IMPROVEMENT SUGGESTED.

(160) We shall now proceed to consider the customary methods of measuring lime. This article, which is of great importance in Architecture and other arts, as well as in Agriculture, ought never to be sold by weight; because quick lime, in its most perfect state, is lighter than that, which has either been burned imperfectly, or which may have been injured afterwards, by exposure to damp or even to air for any length of time.* But even the measurement of lime, which therefore is the only proper expedient for judging of quantity, is a delicate operation; for the same injurious exposure to damp or air, not only increases its weight, but may also alter its bulk, by partially slaking it. Hence lime can scarcely be measured fairly, except when fresh from the kiln.

(161) Lime has been sold in the South of England from time immemorial, by a quantity called "the Hundred," which was usually served out in 25 bushel baskets, or in 50 half bushel baskets, of Winchester measure not heaped, until the imperial measures were introduced; after which, although some Lime-burners still adhere to the old system, others serve out the hundred of lime in 18 large bushel baskets, each capable of containing in level measure the same quantity as the heaped imperial bushel ought to do. But to save the trouble of measuring by one basketful at a time, the principal Builders of the Metropolis, rejecting this tedious process, have agreed to receive a cubic yard measure of lime, raised one inch higher than the top, as the hundred of lime. In the present state of the lime trade of this country, the term "hundred" therefore tends only to render lime measure unintelligible to the public in general, since it is evident that nothing can be more absurd than to call 25 small, or 18 large, bushel baskets, or 1 cubic yard and a small fraction of a cubic yard, by that term, which was appropriate and significant two or three centuries ago, when lime was measured by the single peck of old English

* Hence the sale of lime by weight, unknown at all times in England, was very properly prohibited in Ireland, by a law of the Parliament of that country before the Union.

Corn measure not heaped, and priced by the hundred pecks, which is the identical quantity now under discussion. The old hundred of lime, of which term the origin has just been explained, differs from the contents of the 18 imperial bushels heaped, or half chaldron of lime, as this quantity is also termed, by about one-fifteenth part in excess, and from the contents of the cubic yard measure raised one inch, by about one-tenth part in excess; but they are all reckoned equal, as measures of quantity, by the dealers in lime, and I believe justly so, for the reasons stated in Article 151. If the obsolete term hundred were abolished, lime measure, such as it now stands, would be rendered intelligible, whether as estimated by the imperial chaldron of heaped measure, or by the cubic yard, of which two modes of measurement the last is the most judicious.

(162) The system of lime measure, which has been adopted for many years past in the Royal Engineer Department, by order of the Board of Ordnance, may however be considered the best of all. In that Department, lime is always priced by the cubic foot, but it is measured by the cubic yard, giving full measure not heaped nor raised upon, and also occasionally by the half yard, which latter quantity is frequently required in the repairs of buildings. The vessel used as a measure is made of wood, and usually in two parts, open at top and bottom, each measuring 3 feet square in the clear, and 18 inches high; so that one part singly measures the half yard, and the two combined measure the whole yard. A measure of one cubic foot is also provided, in addition to the above, for measuring smaller quantities than the half cubic yard, when required.

(163) The only improvement upon this system, that appears necessary, is to abolish the cubic yard measure of 27 cubic feet, and the half cubic yard measure of 13½ cubic feet, both being too unwieldy, and both being very aukward multiples of the cubic foot, especially the latter, which is embarrassed by a fraction; instead of which I propose that lime shall be measured in future by the 10 cubic feet measure, previously recommended for measuring sand and corn, in Articles 79 and 138, and capable of being divided into 2 equal parts; for although this measure is smaller even than the half cubic yard, I found, on having one made for trial, that the power of using it occasionally in two parts, was a very great advantage.

(164) I shall conclude by observing, that all large masses of lime stone must necessarily be broken, before they are

burned, into pieces of about three or four to the cubic foot for a flame kiln, and into pieces of about two hundred to the cubic foot for a common kiln.* Hence the size of both kinds is in such proportion to the proposed vessel of 10 cubic feet, in which they are to be measured, that no increase of measure can arise to the benefit of the Dealer, and to the prejudice of the Purchaser, by the former breaking his flame burned lime smaller. Indeed this practice, which would be prejudicial to the Lime-burners, in measuring by so large a measure,† has never been resorted to by them, even in measuring with the basket, in which case the breaking of large pieces into small might probably have made some little difference in their favour. Their custom has always been to sell their lime in the same state in which they have drawn it from the kiln; and nothing can be fairer.

OF THE CUSTOMARY METHODS OF MEASURING FISH AND FRUIT.

(165) The Fish usually sold by measure are fresh sprats, fresh herrings, oysters, and all the smaller kinds of shell fish.

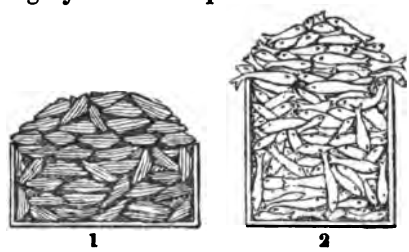
In freighting a vessel with oysters for the London market, large measures called tubs are used, which vary in different parts of the Coast;‡ but at Billingsgate market, oysters are always measured by a half bushel measure of the imperial standard, having its diameter double of the depth, as by law directed; and sprats are also measured by a half bushel measure of the same capacity as the former, but so far differing from it, that its depth is nearly equal to its diameter. Besides this deviation from the existing laws, in the measure used for sprats, which is technically termed a "Toss," each of those two measures, although containing exactly two imperial pecks when stricken, is called a peck measure, and four of these measures are called a bushel; and thus oyster and sprat measure are

* In a flame kiln powerful fires act as furnaces for burning the fragments of lime stone above, which are prevented from falling into them, by being built in the form of rough arches; and this kind of kiln is generally covered by a brick dome. In a common kiln, formed like an inverted cone, open at top, the small pieces of lime stone are intermixed with the fuel in alternate layers.

† I am informed by an eminent Builder, who tried the experiment, that on receiving a cubic yard of flame burned lime, he ordered it to be broken into smaller pieces, after which it did not fill the same measure, but stood 4 inches lower than the top, which made a deficiency of 3 cubic feet in 27, being one-ninth part of the whole quantity.

‡ The Rochester oyster tub is intended to contain 2 bushels of Imperial measure.

both double of the usual measures of the realm, so that when a fishman offers to sell ten bushels of oysters or of sprats, he means 20 legal bushels. This abuse of language is in itself an evil, which ought to be prohibited, but to add to the confusion thence arising, oysters and sprats are not measured in the same manner. The custom in measuring the former is to throw in the oysters irregularly by a shovel, until they stand level with the brim of the measure, after which they are carefully piled by the hand in a convex heap, which is raised about four inches higher than the brim, or sometimes a little more. In measuring sprats on the contrary, the custom is, after filling the measure, to continue throwing on as many more sprats by the shovel as possible; and as these small fishes adhere together to a certain degree, those which form the external base of the heap, project on each side beyond the brim of the vessel. These discordant modes of measuring oysters and sprats are shown in the annexed figures, of which the first represents the oyster peck measure heaped, and the other represents the sprat peck measure heaped, according to the custom of the celebrated fish market before mentioned.



1 2

(166) Independent of the difference thus unnecessarily created, between the nominal peck of oysters, and that of sprats, which ought to be the same, I am informed that a considerable difference of quantity can be made in both of these commodities, in using the same measure, by the person employed to fill it, accordingly as he may be disposed to measure heavily or lightly. In respect to oysters in particular, the difference which may result from this cause, is said to vary from about 6 to 12 per cent of the whole quantity to be measured.*

After being measured in the hold of the fishing vessel in the manner before described, oysters and sprats are carried off in any kind of basket, which the fishman who pur-

* The persons employed in actually measuring oysters at Billingsgate, are called Fellowship Porters, who are responsible to an Oyster Meter, acting by authority of the Lord Mayor of London. In my inquiries into the system of that market, which led me there repeatedly, I met with nothing but civility from all classes to whom I addressed myself, and witnessed nothing of that vulgar insolence, for which Billingsgate has been considered proverbial.

chases them thinks proper to use, of which there is a great variety; but the basket commonly used for sprats contains the same quantity in level measure as the heaped measure used, the contents of which are emptied into the basket which is placed on deck, by dexterously throwing up the heaped measure from the hold, and turning it over as it falls.

(167) Muscles, periwinkles, cockles and wilks, are sold at Billingsgate by a wooden measure called a "Wash," which is considerably larger than that by which oysters and sprats are sold, being nearly equal to two-thirds of the present imperial bushel, as I found by examining one that was used in that market. Hence the wash is not an aliquot part of any known legal measure, besides which, the measurement of those small shell fish before enumerated is subject to another irregularity, inasmuch as some dealers use a shallow wash of large diameter, whilst others use a deeper one of less diameter, producing unequal quantities when heaped. Moreover by a curious custom, not to be accounted for on any rational principle, level measure is used for wilks, whilst all other kinds of small shell fish are heaped as high above the brim of the wash, as their nature will conveniently permit; and by a still greater incongruity, the wash of cockles is called a bushel, whilst the wash of muscles periwinkles and wilks is called a peck, although its contents are not much less than three legal pecks.

(168) Whilst fresh sprats and herrings, oysters, muscles, &c., are measured in the manner that has been described, soles are sold by baskets, termed bushel baskets, which are considerably smaller than the legal bushel, but which are not always equal to each other. In these baskets, the soles are packed with their heads downwards, until the basket is heaped about four inches higher than the top; the average number contained in each basket being about 100. This practice, however, only prevails in winter, or in cold weather, when soles will keep for some time, if properly treated.

(169) Upon the whole, the customary methods of measuring those kinds of fish, which are sold by measure in the London markets, are uncertain and inconsistent, a mystery to the public in general, and entirely at variance with the existing laws on this subject, for the only legal measure used, that which applies to the measurement of oysters, is called by a false name, and so are all the other measures used there without exception; for it may have been inferred from what I said before, that whilst the Billingsgate bushel of cockles is scarcely two thirds of a legal

bushel, the average sized Billingsgate bushel basket of soles is only about three fourths of that quantity, the Billingsgate bushel of sprats or of oysters is equal, or nearly equal, to two legal bushels, and the Billingsgate bushel of all other small shell fish is not much less than three legal bushels.

OF THE CUSTOMARY METHODS OF MEASURING FRUIT.

(170) The more delicate kinds of fruit are generally sent to the London market, in light wagons or carts loaded with neat compact cylindrical baskets called Sieves, piled in several tiers one above another. They are of two kinds, cherry sieves and currant sieves, each of which has its corresponding half sieve. The dimensions of those sieves have been fixed by custom, and all respectable and fair dealing Market Gardeners endeavour to have their sieves made to correspond with the customary standards, and as nearly equal as possible; and good basket makers will produce greater uniformity, than could reasonably be expected, from the nature of the materials they work with. Having measured several well made cherry sieves, I find that the capacity of the smallest in level measure exceeds the stricken imperial bushel by about one-eighteenth part, whilst the capacity of the largest exceeds it by about one-ninth part, the mean capacity between those extremes being nearly equal to 2400 cubic inches, which differs from the imperial bushel by about one-twelfth part in excess. The currant sieve is a little deeper and narrower, and is said to be intended to contain somewhat more than the cherry half sieve, although I have found some of those two kinds to measure so nearly alike, that it appears to me, that the sieves of the Market Gardeners might have been simplified, by having only three sizes, namely a sieve, half sieve, and quarter sieve, without reference to cherries or currants in particular. I think it probable, that the cherry sieve was originally intended for a bushel measure of nine Winchester gallons to the bushel, that the half cherry sieve and currant sieve were each intended for the half bushel, and that the half currant sieve was intended for the peck or quarter of the above bushel, which must have been common in England, from the circumstance of repeated Acts of Parliament having been made to prohibit the use of 9 gallons to the bushel; but which did not affect the Market Gardeners, in consequence of their fruit sieves not having been mentioned by name in any such Statute. Even now the term bushel sieve is commonly applied to the cherry sieve, but not by

the Market Gardeners or dealers in fruit on a large scale, who always sell those kinds of fruit, which they pack in sieves, by the sieve, and not by the bushel. But by a strange anomaly, which appears to depend upon the pleasure of the Market Gardeners individually, sieves are sometimes filled in level measure to the height of the brim only, at other times they are heaped with fruit three inches higher, which makes their contents fully equal to those of the heaped imperial bushel; and as delicate fruit thus heaped would be crushed, by piling one sieve above another, a piece of basket-work called a rim, about 3½ inches high, open at top and bottom, and shaped like the lower part of a cone, is placed upon each sieve to protect the heaped portion of the fruit. The bottom of every rim exactly fits the top of each sieve, the two together composing as it were one measure, and the second tier of sieves rests upon the top of the rims of the first tier, and thus the fruit wagon or cart is packed with sieves and rims alternately; excepting that basket-work tops are sometimes used for the uppermost sieves, which rise in such a manner as to admit of the sieve being moderately heaped.

The other fruits conveyed in sieves may be heaped or not, but cherries being sold by weight are never heaped, as the sieve can conveniently contain 4 dozen or 48 lbs. of that fruit, which has accordingly been fixed, as the understood quantity packed in every sieve.*

(171) Fruit sieves and half sieves are objectionable as measures, for as their dimensions are fixed by custom and not by law, every Market Gardener may order them according to his own pleasure, and the Fruiterers in particular may purchase by a large sieve and sell by a smaller one, without being liable to any penalty.

(172) It is however only the more delicate kinds of

* The cherry sieve is to be 8 nails (18 inches) in diameter at bottom, and 5 nails (11¼ inches) deep; and the half cherry sieve is to be 6½ nails (14⅝ inches) in diameter at bottom, and 4 nails (9 inches) deep.

The currant sieve is to be 7 nails (15¾ inches) in diameter at bottom, and 3½ nails (7⅞ inches) deep: and the half currant sieve is 5½ nails (12⅜ inches) in diameter at bottom, and 3 nails (6¾ inches) deep.

When stowed in the fruit wagon, each kind of sieve occupies 2 inches more in exterior diameter, at the rim, which is the widest part, and 1 inch more in extreme height than the above dimensions. The bottom of every sieve is concave below and convex upwards, rising about an inch and half, for the sake of strength, and the brim projects about half an inch inwards all round, so that it is more easy to ascertain the capacity of fruit sieves practically than by calculation.

The circumstance of the Basket Makers determining those dimensions by the nail, which is not used by any other workmen of the present day, sufficiently proves the antiquity of the Market Gardener's sieves.

fruit which are sold by the sieve, apples, pears, &c. being usually sent to London in large baskets, or hampers, of which there is a great variety of shapes and sizes, apparently capable of containing from about two to five cubic feet, and which have each their several names, such as maunds, sack maunds, loads, barges, pads, &c.* The loads, barges, and pads usually have covers. The fruit in the maunds is moderately heaped so as to rise a little in the center, and is then well secured at top by straw and cordage. The fruit brought from the country in these large packages is usually transferred into baskets, larger at top than at bottom, and having their height a little greater than their extreme diameter, and which are of several different sizes, apparently decreasing from about one bushel downwards. In these baskets the fruit is always piled in the form of a cone, as high as it can conveniently stand, and is thus exhibited for sale, by the Fruiterers in the London Markets, who never sell it by the bushel, but by the particular basket in which it is contained whether large or small, without applying the name of bushel, half bushel, peck, or any other legal measure, to any of those baskets. Others expose their fruit for sale in sieves, heaped only about four inches higher than the brim. By persons who go into the market themselves to purchase, the inconveniencies of this system are less felt, for they can judge of the contents of any basket or sieve offered to them for sale by inspection, or at least by trial; but even to such persons the circumstance of different Fruiterers using different sized baskets and sieves, cannot fail to be in some degree embarrassing: and a very serious evil results from such uncertainty, namely, that fruit measure is perfectly unintelligible to the public in general.

(173) In respect to the retail of fruit, as sold in the streets, or at Green Grocers' shops, by the quart or pint, it is always heaped; but those small measures are of all shapes, some deep and narrow, others shallow and broad; so that it is impossible that the contents of all those which bear the same name can be equal.

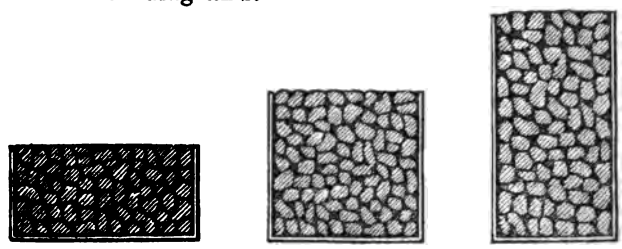
(174) The inconsistency of the present customary methods of measuring fish were before commented upon; and from what has just been stated, in respect to the mea-

* Of those packages, the maund is the smallest, and is shaped like a common basket, having its height rather greater than its extreme diameter. The sack maund is a larger one of the same shape. The pad is a rectangular hamper of superior workmanship. The load is a broad but shallow basket, not so convenient for stowage as the barge, which is an oblong basket, having its width not much more than half of its height or length, the two latter of which are nearly equal, and measure about 2½ feet.

surement of fruit, it is so difficult to form a just notion of the practice of the Market Gardeners, and of the numerous sieves, baskets, &c. used by them, even at Covent Garden; that I conceive it would be labour lost to attempt to investigate the multifarious fruit measures, in all probability differing from the above and from each other, which may be used in other parts of the kingdom. The only possible means therefore, of getting rid of the extreme uncertainty and confusion attending our present fish measure and fruit measure, appears to be the proposition before suggested to abolish heaped measure entirely, and to substitute the cubic foot, instead of the discordant bushel measures, pecks, tosses, sieves, and baskets now in use; which by a strange caprice are sometimes heaped and sometimes not heaped, and which when heaped are of various shapes, and consequently of various sizes, although of the same denomination, without the smallest regard to the existing laws, according to which the sale of fish and of fruit by measure are supposed to be regulated.

THE ABSURDITY AND INCONVENIENCIES OF HEAPED MEASURE FARTHER EXPLAINED.

(175) As an example of the absurdity of heaped measure, three measures, each supposed to be cylindrical, and each of exactly equal capacity, are represented in section, in the annexed diagrams.

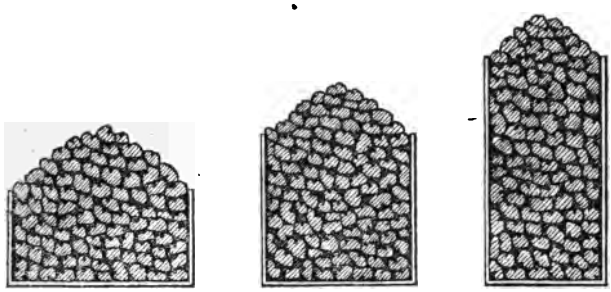


1 2 3

Fig. 1, is a measure having its diameter double of its depth, like the present legal imperial bushel of heaped measure. Fig. 2, is a measure having its diameter equal to its depth, like the present imperial bushel of stricken measure, of the form usually termed the drum bushel: and Fig. 3, is a measure having its diameter only one half of its depth, a proportion never used except for measures much smaller than the bushel, but which has been assumed for the sake of illustrating the principle, now under discussion.

Supposing heaped measure to be abolished, these three measures will hold precisely the same quantity, when filled up to the level of the brim, whether with liquor or with corn, and they will also hold the same average quantity of fish, fruit, coals, lime, &c. as nearly as irregular solids are capable of being measured, which for the reasons before stated in Articles 147, 149 and 151, does not admit of absolute precision.

(176) Now if the same measures be heaped up with dry goods, in the manner prescribed by law, in using the present imperial bushel, in which the height of the cone or heap is nearly equal to one third of the diameter, as represented in the second set of diagrams subjoined, the original equality of these three measures will be completely destroyed; for as the three several heaps are similar solids, and therefore in proportion to the cubes of the respective diameters of the vessels upon which they are raised, the heap upon No. 1, the shallow measure, will be double of the heap upon No. 2 the medium measure, and rather more than four times the heap upon No. 3 the deep measure. Hence although the contents of the three vessels in level measure are exactly equal, by heaping these measures, the total quantity measured upon No. 1 will be as $1\frac{1}{4}$, that upon No. 2 as $1\frac{1}{8}$, and that upon No. 3 as $1\frac{1}{16}$ nearly, or by getting rid of fractions, the quantities measured by each of those three measures will be respectively as the numbers 20, 18, and 17.



1 2 3

Thus the value of our English legal heaped measure as represented by No. 1, will be reduced 10 per cent by using a deeper measure like No. 2, such as is used in the measurement of sprats; and nearly 16 per cent by using a still deeper measure, like No. 3, such as is frequently used by Green Grocers in the retail of fruit.

(177) By abolishing heaped measure, vessels of any shape, the most convenient in practice may be used for measuring goods; whereas the use of this kind of measure renders it absolutely necessary, that all vessels used as standards shall be of the same shape, or in exact proportion to each other in all their like parts, which imposes a restriction so exceedingly inconvenient, that although agreeable to the present law, it has been rejected by the public, who pay no attention to it, except in discharging the cargoes of coal ships, the measurement of which has not been left as a private transaction to the Coal Merchants and the persons with whom they deal, but has been confided to Coal-Meters, who are bound to adhere to the letter of the law, from which they derive their power. But even in the measurement of coals, as conducted by that class of men at most of the ports of England, the bushel basket of level measure, equal to the heaped imperial bushel, is used for measuring and drawing up every bushel of coals from the hold of the ship, and from this basket they are discharged into an imperial standard bushel measure for form's sake, which ceremony causes a part of the contents of the basket, on being poured into that flat measure to fall upon the deck, and the coals thus spilt must be made good again, before they are finally poured out of the bushel measure into the barge or cart alongside. Thus the use of a heaped bushel measure, which can scarcely be filled, and which cannot be moved, without spilling a part of its contents, only causes unnecessary trouble and waste of time. If no such thing as heaped measure had been allowed, the use of two measures, a basket and a bushel measure, and virtually of two measurements, would have been unnecessary in unloading a coal ship; and the baskets of the retail dealers in fish and fruit, being made with a little more care, might have answered the double purpose of market baskets, and of correct measures of the legal standards by which those commodities were directed to be sold.*

(178) What adds to the uncertainty of heaped measure is the circumstance, that one cannot calculate that the heaps raised upon the same measure shall be exactly alike, in any two successive measurements, without employing a double measurement, such as that which has just been described in

* This system of basket measure is followed in all the Government Departments, in which it is the invariable custom to serve out coals to the troops in Barracks, and to other persons who are entitled to receive them, in bushel baskets containing in level measure the proper quantity, which belongs to the imperial bushel basket heaped.

respect to the unloading of coal ships, and which virtually amounts to the setting aside of the practice, although not of the principle of heaping. For example, the height of the cone upon the present legal imperial bushel-measure ought to be six inches; but I have found by repeated trials, that the eye cannot judge correctly of this height, without having recourse to actual measurement by a scale of inches, which is never done in practice, and which no reasonable person could insist upon. Therefore even with a strong desire to act impartially, no Coal-Meter could be responsible for accuracy of measure by the heaped bushel, since the upper surface of the heap involves an imaginary figure, which must be traced in the air, without any thing to guide the eye. In level measure on the contrary, no error can possibly arise; for in the measurement of such goods, as cannot conveniently be stricken, it is only necessary to look along the top of the measure from one side to the other, by which the purchaser can easily see, whether they stand level with the brim or not.

THAT THE CUBIC FOOT IS THE SMALLEST MEASURE, WHICH OUGHT TO BE USED IN WHOLESALE DEALINGS IN FISH OR FRUIT. THAT WEIGHT MIGHT GENERALLY BE ADOPTED IN PREFERENCE TO MEASUREMENT.

(179) In abolishing heaped measure, and establishing the new cubic foot as the unit of all measures of capacity for the future, it may be remarked, that apples, pears, walnuts, and other fruits not liable to be crushed by stowing them away in mass, and also potatos as well as sprats and oysters, may be sold by the ten-cubic-feet measure; whilst the more delicate kinds of fruit may be sold by the cubic foot, which is the smallest measure that ought to be used in wholesale dealings either in fruit or in fish, and which if converted into a fruit sieve will form a package as well as measure, containing three-fourths of the average contents of the present cherry sieve, and not liable to the extreme uncertainty attending that, as well as all the other packages, used in the fruit trade. Whilst the cubic foot will thus form a very convenient new sieve, those Gardeners who desire to pack their fruit in larger quantities, may make use of 2 feet sieves, or of baskets or boxes, measuring respectively 2, 3, 4, or 5 cubic feet. For in all cases the package used in the wholesale of fruit, should either be the cubic foot itself, or should contain an integral number of cubic feet. And in this case rectangular fruit boxes would

be found very convenient, for if there were any doubt as to their contents, the purchaser would only have to measure their interior length, breadth, and depth, in feet, and decimal parts of a foot, and to multiply these three dimensions together, which will give him the correct quantity in cubic feet.

(180) As applied to the measurement of fish, the new cubic foot will not differ much in quantity, from the measures now used for that purpose at Billingsgate market, whilst it will produce considerable improvement, by doing away a good deal of the uncertainty attending those measures. For example, the new cubic foot will be very nearly equal to the proper contents of the heaped wide and shallow wash for periwinkles, &c. whilst it will only exceed that of the deeper wash also used there, for the same small shell fish, by about one-seventeenth part. It will differ from the heaped measure of oysters, improperly called the peck, by about one-seventh part in excess, and from the toss of sprats by about one-third part in excess. In respect to fish occasionally sold by the package, as for example, red herrings and oysters by the barrel, pickled salmon by the kid, &c, &c, I need scarcely repeat that the same rule should apply as in respect to fruit, namely that such barrels or other packages should either be equal to one cubic foot, or to two, or three, or four, or some other integral number of cubic feet.

(181) For retail dealings in fish and fruit, the half cubic foot, the can, quart and pint, may also be used, in reference to the respective size of the several articles required to be measured, it being understood that small articles such as nuts, cockles, muscles, &c. may be measured accurately enough by the pint, whilst larger articles, such as apples or pears, could scarcely be measured accurately by a smaller measure than the quart or the can.*

(182) It is proper to observe, that measurement is only used in the London Market, for the particular kinds of fish and shell fish, which have been before specified in Articles 165, 167 and 168, and for some other kinds of fish which are of still less value, being scarcely used at all excepting for manure. Salmon, perch, carp, tench, and jack fish are sold by the pound weight, and eels by the 20 lbs, technically termed the "draught of eels." Most other kinds of fish are sold by number or by tale, but the mode of counting

* Generally speaking it may be remarked that the fairest mode of proceeding in the retail of apples, pears, and all other fruits except very small ones, such as nuts, is to have recourse to tale, for all quantities less than a quart, in preference to the use of such a small measure as the pint.

them for sale is very capricious. Sturgeons, hollibuts, scates and large turbots are sold singly. Smaller turbots are sold by 4, 8, 10, or 12 at a time; codfish by 4, 6, 10, 16 or 20, according to their size; haddocks by the dozen or half dozen; flounders and sometimes smelts by the long dozen of 13; whitings by the 15, two or three fifteens being called a-lot; salt cod and lobsters by the score; dried sprats, red herrings, and smelts by the hundred; mackerel by the long hundred of 120, by which whitings and fresh herrings are also sometimes sold. In hot weather soles also are sold by tale, for as they then require to be conveyed alive to the neighbourhood of London, in boats having trunks or reservoirs at bottom, perforated with small holes to admit the water, it is not worth while to pack them. The arrangement adopted for the sale of soles in this case is very curious. Seventeen pairs, or 34 soles, are sold together, constituting what is technically termed a "Row," of which 3 pairs are large, 6 pairs middle sized, and 8 pairs small. This term was adopted, because the soles offered for sale are laid out in rows of the above number and size for inspection.

(183) In London, potatos are invariably sold by weight, which is a much better system, than to sell them by the sack of about three bushels, more or less, according to the practice which prevails more generally in the country. I am informed, that in some parts of the North of England, the sale of fish and fruit by weight is carried to a much greater extent, than in the Metropolis or in any part of the South of England; and it appears to me, that with the exception of oysters and other small kinds of shell fish, and of walnuts and other small nuts, which may perhaps most conveniently be measured, the adoption of the North Country custom of using weight, to the exclusion of measure, would be an improvement: for although neither fish nor fruit can be cut smaller like coals, for the purpose of increasing apparent quantity to the prejudice of the purchaser; and although fruits are less liable to that uncertainty, which may arise from the dexterity of heavy or light measurers, than most other commodities; yet upon the whole it must be admitted, that in all cases, weight cannot fail to yield a much more accurate test of proportional quantities, both of fish and of fruit, than the most improved system of measurement can possibly afford.

THAT THE CUBIC FOOT IS THE ONLY STANDARD MEASURE, NOT LIKELY TO BE ALTERED IN PROCESS OF TIME, LIKE THE OLD ENGLISH STANDARDS OF MEASURES OF CAPACITY, AND OF WEIGHT, WHICH HAVE ALL BEEN CHANGED MORE OR LESS, SINCE THE NORMAN CONQUEST.

(184) Before I proceed to the next branch of my subject, I may be permitted to observe, that the cubic foot from its preeminently intelligible nature and extreme simplicity, appears to be the only kind of measure of capacity, which one can reasonably hope to fix permanently and invariably.

In the first place, it is liable to no uncertainty, for unlike the common measures of capacity of this and of other countries, the cubic foot measure cannot be heaped; inasmuch as such a measure, if heaped, would immediately cease to be the cubic foot, in that acceptation of the term, which prevails amongst all nations, without exception, and which, in the present state of education and of mathematical knowledge, can never be altered.

(185) Secondly, It is the only kind of measure of capacity, which is not liable to be adulterated or changed in times of turbulence and anarchy, for it is one which no government in any country, even the most ferocious despotism or democracy, can have any possible interest in altering. I conceive that this opinion has been sufficiently corroborated by our own annals, since the time of the Anglo-Saxons, which have had their full share of foreign and civil wars, of tumults and commotion, violence and spoliation. For if the history of the measures and weights of England during that long interval be investigated with due attention, it will be found that all of them have undergone considerable changes, with the exception of our lineal measure, and as none of these changes were intentional, excepting those made in the coinage, which was depreciated from time to time by several of the Kings of England, when pressed for money; it may reasonably be allowed, that if our ancient measures of capacity had originally been made to depend on lineal measure, by taking the cubic foot for the standard of the former, as the yard rod of three feet was the standard of the latter, the invariability of the latter must have fixed the former also, in a permanent manner.

(186) Instead of the above, a contrary system was adopted of making the gallon, which was the unit of our

ancient measures of capacity, to depend upon weight alone, without reference to lineal measure at all; for the old English wine gallon was intended for and declared by the most ancient laws on the subject, to be an eight pound measure of wine;* whilst it appears to me that the old English corn gallon, although not so defined in any of the statutes, that I have met with, before the reign of Henry the Seventh, must in like manner have been intended for an eight pound measure of wheat. Unfortunately there were always two different pounds used in England, one for weighing money, bullion, jewels, medicines, &c, the other for common commercial purposes, and with the gradual changes of these pounds, both of which increased beyond their original value, until the former merged into our present Troy weight, and the latter into our present Avoirdupois weight,† the wine and corn gallons increased also; but more irregularly,

* The earliest laws, in which any precise information is given as to the value of the standard weights and measures of England, are marked as being of uncertain date, in the Statutes of the Realm printed by command of His Majesty King George the Third, in pursuance of an Address of the House of Commons, from original Records and authentic Manuscripts. The first is entitled Assiza Panis et Cervisiæ, and was supposed to be an Act of the 51st of Henry the Third. The second is entitled Assiza de Ponderibus et Mensuris, and was supposed to be an Act of the 31st of Edward the First. See Statutes of the Realm, vol. I. pages 199 and 204.

† The old Anglo-Saxon money pound, afterwards called the Tower Pound, from the business of the Mint having been carried on in the Tower of London, consisted of twelve ounces, whilst the Anglo-Saxon Merchant Pound, or Commercial Pound, consisted of fifteen ounces of the same weight. King Henry the Eighth and his Council, by a verdict or order of the Exchequer of the 30th of October 1527, directed that Tower weight should be entirely abolished, and that all manner of gold and silver, sent to the Mint to be coined, should be weighed in future by Troy weight only, and fortunately the proportion between the old and the new pound was stated not only in that document, in which it was declared, that the pound Tower weighed eleven ounces and a quarter Troy, but also in a prior law of the 2nd of Henry the Sixth, chap. xvi. (1423), in which it was stated that thirty shillings of silver bullion or plate the pound Troy, was of no more value at the Coin (implying the Mint) than thirty-two shillings.

Hence the old Money Pound of England must have been equal to 5400 grains of our present Troy weight, of which the Troy Pound itself contains 5760: and the old Merchant's Pound, or Commercial Pound of England, was equal to 6750 grains of our present Troy weight, of which our present Commercial Pound, or Pound Avoirdupois, contains 7000.

Originally the silver penny coin of sterling English money was also the penny weight, being the twentieth part of the Anglo-Saxon Ounce, from which the old English money Pound of twelve ounces was determined, which pound was also identical with the pound sterling before the depreciation of the original coins of England took place. Now the most perfect English silver pennies still extant, several of which were coined before the period of the Norman Conquest, weigh 22½ grains of our present Troy weight, from whence we obtain 5400 grains Troy, as the exact value of the old English money pound. This remarkable coincidence fully proves the accuracy of the foregoing estimate of the value of the old English money pound.

and the latter in some proportion which is not easy to trace, especially as wheat has no fixed specific gravity. Hence the precise value of the corn gallon, although intended by law to be an eight pound measure of wheat, could only be known in the early periods of our history, by a reference to the standard gallon kept, for the time being, in the King's Exchequer, where the legal standards of all other measures, as well as those of weights, were likewise preserved; and which were of course renewed from time to time, in proportion as the old standards became worn or injured. Now in the renewal of the standards of measures of capacity, which it is not easy to copy correctly, considerable difference between the new and the old must undoubtedly have taken place from bad workmanship; as is sufficiently proved by the incongruity of the corresponding sets of pint, quart, gallon, and bushel standard measures, made in the reigns of King Henry the Seventh, and of Queen Elizabeth, still extant; no two of which, of the same denomination, were equal, and no two of different denominations, even in those of the same reign, were the exact parts or multiples of each other, that they ought to have been.* But in addition to the changes arising from this cause, other more considerable alterations took place, both in respect to weights and measures of capacity, which were so far unintentional, that in some cases they were made in error, for the declared purpose of restoring ancient standards, from which in reality they were departing.† In short, as I said before,

* See the Report of the Committee of the House of Commons on Weights and Measures, reported by Lord Carysfort 26th May 1758. This Committee caused all the standard weights and measures extant, not only those in the Exchequer, but also those at Guildhall, at the Mint, and other official places, to be carefully examined, and their proportional values to be accurately ascertained. The standards of lineal measure and of weight, had previously been examined and reported upon by order of the Council of the Royal Society. (See the Philosophical Transactions for 1743).

† This has happened more than once in the course of our history, but I allude more particularly to the Acts for Weights and Measures of the 11th of King Henry the Seventh, chap. iv. (A.D. 1495), and of the 12th of the same King, chap. v. (1496-7), on perusing which two statutes, it will be found that the first directed an entire new set of standard weights and measures to be made of brass, and sent to the principal County Towns, &c. of the Kingdom; whilst the second developes the curious circumstance, that all the standard gallon and bushel measures thus made had proved defective, although they had been copied from the standards remaining in the Treasury; and therefore they were called in to be broken and destroyed, and other more accurate brass gallon and bushel measures were to be made and circulated instead of them. This confusion appears to have arisen chiefly from the erroneous supposition, adopted at that period, and expressly stated in the second of the above statutes, that Troy weight was the weight intended in the old Laws of the Land, whereas the Troy Pound and the Avoirdupois Pound appear gradually to have superseded the old English Money and Commercial Pounds, by usage, before they were established by law, so that Henry the Seventh, whilst acting under this erroneous impression, did not restore, but alter the ancient Weights of England.

the English yard, the standard of lineal measure, is, of all our old standards, the only one which is not known to have been altered since the time of the Anglo-Saxons, whose weights and measures were adopted and confirmed by William the Conqueror, and his successors.* Some change must of course have taken place, through careless workmanship, at the several periods when the more ancient standard yard rods, were successively renewed; but I think it may be allowed that, in so simple a task, as the replacing of one iron or brass yard rod, by another of equal length, it is not likely that an alteration of much more than a quarter of an inch should have taken place since the period of the Norman Conquest.†

(187) The uncertainty as to the precise value of the English corn gallon was not removed, until the thirteenth year of the reign of William the Third (1701), when the Winchester bushel was first defined by law as a cylindrical measure, eighteen inches and a half in diameter, and eight inches deep: but the wine gallon was not properly defined until the following reign, when it was declared to be a cylinder seven inches in diameter and six inches deep; and its contents were stated as being equal to 231 cubic inches, although this quantity exceeds the correct estimate derived from the above dimensions, by about one-tenth of an inch. The corn gallon was again disturbed in the reign of George the Third, when its value was declared by one law to be 272, and by another 272¼ cubic inches, whereas its true value, as deduced by calculation from the lineal dimensions assigned to the bushel by the statute of William the Third before quoted, was only 268·8 cubic inches; and as this statute was not repealed, the ridiculous circumstance occurred, that the corn measure of this country had three different values, all equally legal.

(188) In the mean time beer measure, which was not originally used in England as a separate measure, nor recognised as such by any of our ancient laws, had been

* This is proved by the following extract of an Edict of William the Conqueror, from a book entitled Leges Anglo-Saxonicæ, by David Wilkins, Canon of Canterbury, published in 1721. "Et quod habeant, per univer-" sum regnum mensuras fidelissimas et sigillatas, et pondera fidelissima et " sigillata, sicut boni predecessores statuerunt."

† I consider this to be the fact, in spite of a story handed down in some ancient Chronicle, and noticed by Wilkins, the same author quoted in the preceding note, namely that King Henry the First, a tall big man, established the length of his own arm, as the standard of lineal measure. It appears to me much more probable, that the King's arm should have agreed with the standard yard of England, than that he should have altered this national measure to suit his own arm.

introduced for the first time by an Act of the 12th of Charles the Second, chap. 23 (1660), when a tax on beer was imposed, which was to be levied "by the standard of the ale "quart in the custody of the chamberlain of His Majesty's "Exchequer." Now if the beer tax had been ordered by that law to be regulated by the standard of the gallon in the Exchequer, whether designated as an ale gallon or not, no innovation in the old system of English measures would have taken place; but through bad workmanship and neglect, the standard quart kept in the Exchequer proved to be considerably larger than the fourth part of any of the standard gallons kept in the same office at the same time. And thus through sheer neglect of the official persons at some former period, who ought not to have received such incongruous measures from the workmen who made them, the large quart now alluded to, led to a larger gallon being used for beer than for any other commodity; and accordingly beer measure became a distinct measure.*

(189) No less egregious an error had taken place, in respect to the wine gallon, which originally appears to have been an eight pound measure of the old English commercial weight,† but increased afterwards to an eight pound measure of avoirdupois weight, which was considerably larger than the former, in or about the reign of King Henry the Eighth. The new standard then introduced, having no doubt been constructed according to old custom, in reference to weight alone, and without regarding lineal dimensions or cubic content; when this standard gallon first came

* The standard quart measure of Queen Elizabeth, marked 1601, measured 70 cubic inches, which leads to a gallon of 280 cubic inches, whereas the standard gallons of Queen Elizabeth, both kept in the Exchequer, measured only 271 cubic inches. The standard gallons of Henry the Seventh were a little smaller. The standard bushel of Queen Elizabeth, marked 1601, yielded a gallon of 265½ cubic inches only: but the standard bushels of King Henry the Seventh yielded a gallon of nearly 278 cubic inches. As the bushel was never used for ale measure at all, but for corn exclusively, this last proportion sufficiently proves, that corn measure was not originally intended to be smaller than beer measure; which circumstance, combined with the extreme incongruity of all those standards without exception, may upon the whole be considered a conclusive proof of the assertion made by me, that the excess in the proportional magnitude of the standard quart measure, as compared with others of which it ought to have been an exact part or multiple, was owing entirely to neglect

† The space occupied by eight pounds of wine of the old English commercial weight of 6750 grains Troy, as defined in the Note to Page 99, must have been about 216 cubic inches, and that such was the original value of the old English wine gallon appears to me to be proved by the circumstance, that the legal wine gallon of Ireland, which no doubt must have been introduced by the English, and which was only superseded a few years ago, by the imperial gallon, differed very little from the above, being estimated at 217·6 cubic inches.

to be gaged or measured, it was erroneously estimated at 231 cubic inches instead of 224, which last was the actual size of the said standard, and which agrees very nearly with the space, that eight pounds avoirdupois weight of wine ought to fill. The former erroneous estimate of the wine gallon was however adopted and acted upon by the officers of the Revenue, until the year 1700, when a Merchant having disputed the sum charged against him, as the duty upon some wine which he had imported from Alicant, was prosecuted for the full amount by the Attorney-General on the part of the Crown. The proper value of the wine gallon having thus become the subject of legal inquiry, led to a more correct measurement of the standard wine gallon kept at Guildhall, for the use of the City of London, being the most authentic wine gallon then extant, which brought the above error to light; and what is very curious, as marking the extreme carelessness, which had prevailed in regard to those matters, the original wine gallon in the Exchequer, by which the duties on wine ought to have been levied, and of which the Guildhall gallon must have been a copy, was no where to be found. To put an end to this confusion, and to remove all doubts and matter of litigation for the future, it became necessary to define the wine gallon with greater precision by a new law, in framing which, it was judged more expedient to confirm the erroneous estimate of 231 cubic inches, which had been acted upon for more than a century in the collection of the duties upon wine, than to restore its true value of 224 cubic inches; and thus by degrees, the gallon ceased to be an eight pound measure of wine.

(190) To enter farther into the history of the measures and weights of England would be superfluous, as the object of this treatise is to improve the existing system; and the improvements suggested must rest on their own merits, in comparison with our present standards only, such as they now are, without reference to those which may have prevailed six or seven centuries ago. But I thought it right to allude to the changes, which have taken place, in the lapse of ages, in order that my readers may be fully aware, that with the exception of our lineal measure, none of our present standards are venerable from their antiquity, as might naturally be supposed, by those who have not had the means of studying the subject; they having, on the contrary, been subject to much greater changes than any which I now propose; and all those changes having originated from acci-

dent, error, bad workmanship or neglect, with the exception of two only, namely the wilful depreciation of the coinage, and the introduction of the imperial gallon in 1824, which last change, strange to say, but no less true, is the first and only modification of our original standards, adopted systematically as an improvement, and with a view to the public benefit, in the course of eight hundred years.

To return from this digression, the consideration of Apothecary's liquid measure, although a measure of capacity, will be postponed, until our national system of weights shall have been discussed, on account of the intimate connection of this measure with Apothecary's weight, which forms a part of that system.

OF THE PRESENT STATUTE WEIGHTS OF ENGLAND.

These are divided into three classes, the Tables of which, as stated in elementary books, are as follows.

(191) *First. Of Avoirdupois Weight.*

16	Drams	1	Ounce.
16	Ounces	1	Pound.
28	Pounds	1	Quarter.
4	Quarters, or 112 Pounds	1	Hundred weight
20	Hundred weight, or 2240 Pounds	1	Ton.

This weight is used for the general purposes of Commerce.

(192) *Secondly. Of Troy Weight.*

24	Grains	1	Pennyweight.
20	Pennyweights, or 480 Grains	1	Ounce.
12	Ounces, or 5760 Grains	1	Pound.

This weight is used for gold and silver coins, bullion, and plate.

(193) *Thirdly. Of Apothecary's Weight.*

20	Grains	1	Scruple.
3	Scruples, or 60 Grains	1	Dram.
8	Drams, or 480 Grains	1	Ounce.
12	Ounces, or 5760 Grains	1	Pound.

This weight is used exclusively for preparing Medical Prescriptions.

(194) The Pound Avoirdupois is equal to 7000 grains of Troy weight, or of Apothecary's weight, and this proportion affords the only means of estimating the value of any quantity, stated in the first of those weights, in terms of

the others, or vice versa. Troy weight and Apothecary's weight are identical in all their like denominations, the grain, ounce, and pound of each being respectively equal.*

(195) In the practice of Medical men two remarkable inconsistencies occur. First that although Apothecaries, Chemists and Druggists, purchase and sell their drugs by Avoirdupois weight, they are obliged to compound them into doses for their patients by a different weight; and secondly, that the Physicians, after having adopted the Troy pound, ounce and grain, should have subdivided their own ounce differently, by using the dram and the scruple instead of the pennyweight.

(196) It may be observed, that these three kinds of weight, are a source of the greatest confusion. Indeed although we are all forced to learn them, as school boys, which considering their complexity is a great obstacle to the study of Arithmetic, and as I before observed, to the study of Mathematics generally, yet I believe that there are very few persons, who remember them all in after life. Nor is even a knowledge of those elementary Tables sufficient; for there are perhaps four or five times as many kinds of weights in common use, in various parts of the kingdom, not included in those Tables, which serve still more to embroil this perplexing subject. Those used in the Wool Trade for example are numerous enough to form a fourth Table, which is as follows.

* Dr. Kelly, the author of the Universal Cambist, a very elaborate and useful work on the measures, weights and monies of all the Trading nations of the world, states that the Dram of Avoirdupois weight has sometimes been divided into 3 Scruples, and 60 Grains, like that of the Apothecaries, and that the Grain of Troy weight has sometimes been divided into 20 Mites, each Mite into 24 Doits, each Doit into 20 Periots, and each Periot into 24 Blanks; so that there must be 2880 Grains Avoirdupois in an Ounce of the same weight, and 230,400 Blanks in one Grain of Troy weight. It is scarcely possible to conceive any thing more useless than such minute subdivisions, for no English Tradesman of the present day, dealing in goods sold by Avoirdupois weight, ever uses a smaller weight than a quarter of an ounce, so that even the Dram Avoirdupois is itself an imaginary weight, never used at all in business, much less the Scruple or Grain of Avoirdupois weight. The Periot and Blank of Troy Weight are still more absurd if possible, the largest of the two being only about the ten-thousandth part of a Troy Grain, which is much too minute a quantity, to be observed by the most sensitive balance, that the art of man is capable of constructing. Indeed Dr. Kelly himself states, that these divisions of the Grain are seldom noticed below Mites, except in calculation: but he adds that in weighing, where great nicety is required, decimal divisions are used to the thousandth part of a grain. For my part, I cannot understand, how such ridiculous quantities, as the Periot and Blank, can possibly be applied to any calculation of the smallest practical utility.

(197) *Fourthly. Of Wool Weight.*

7 Pounds .....1 Clove.
2 Cloves, or 14 Pounds .....1 Stone.
2 Stones, or 28 Pounds .....1 Tod.
6½ Tods, or 182 Pounds .....1 Wey.
2 Weys, or 364 Pounds.....1 Sack.
12 Sacks, or 4368 Pounds .....1 Last.

It will be observed, that out of all those denominations, the Tod of Wool of 28 pounds is the only one which agrees with the Table of Avoirdupois weight, before stated, it being the quarter of a hundred weight under a different name. The Sack of Wool is 3 hundred weights and a quarter, and the Last wants 1 hundred weight of two Tons; and upon the whole wool weight is thus rendered unintelligible to the public in general, care having apparently been taken, to use no weight in this branch of commerce, that is to be found in the elementary Table of Avoirdupois Weight, excepting one only, which has been disguised under a different name. But to add to this confusion, the Table of Wool Weight, which I have just given, applies only to the Metropolis, and its vicinity. In respect to the Stone of Wool for example, it varied in North Wales from 4 pounds to 15 pounds. In South Wales, although generally 15 pounds, it varied in several markets from 4 or 5 to 26 pounds. In Gloucestershire it was 12 pounds and a half. In Cumberland, Lancashire and part of Yorkshire it was 16 pounds. In other parts of Yorkshire it varied from 17 to 19 pounds. In Durham it was 18 pounds, and in Northumberland it varied from 18 to 24 pounds.

(198) These varieties in the stone weight of wool, and also in the stone of other commodities, arose from the rude custom, which formerly prevailed in England, of weighing goods by means of a stone, the weight of which varied for the same commodity in different districts, and for different commodities in the same district. When stone weights were supplanted by iron ones, they unfortunately left their name behind them, to which name probably 20 different values are attached in different parts of the kingdom. In London only two stones are generally understood, namely the stone of 8 pounds for Butcher's meat, and the stone of 14 pounds, for other commodities, the latter of which is however seldom used.

(199) Even the pound itself varied in England, as applied to butter, not only in different counties, but in different

parts of the same county, and with one exception only, namely, the pound of 12 ounces occasionally used in some parts of Westmoreland, all the other market pounds alluded to, exceeded the Avoirdupois pound of 16 ounces, since they varied from 17 or 18 to 24 ounces of that weight. Only two of these deviations from the legal pound were sanctioned by Act of Parliament, namely the pound of husks or nuts, which was made 21 ounces by a statute of Charles the Second, and that of raw silk which was made 24 ounces by a Statute of George the Third.

(200) Another term "the Load" is still more indefinite than the stone, for it has been used to denote a prodigious variety of discordant quantities, varying from about four bushels and a half to ninety bushels by measure, and from about one hundred weight and a half to a ton weight. Indeed it could scarcely be otherwise, for in some parts of England, where wheeled carriages were not used, it originally implied the ordinary load of an ass, or of a horse, in other parts it implied the load of a cart drawn by one or more horses or oxen, and in others the usual load of a wagon drawn by several horses or oxen; and these last quantities must have varied further, not only according to the state of the roads, but also to the construction of the cart or wagon in common use in each district.

(201) No person in common life can possibly know all the Stones, and Loads, implying different weights in different districts. Some few only of the numerous loads are known to persons of particular professions or trades. The load of rough timber for example is 50 cubic feet, but that of squared timber 40. This is only known to Timber Merchants and Builders. The load of sand or gravel is 27 cubic feet or one cubic yard. This quantity is understood only by the Builder, and persons connected with building. The load of wheat in Dorsetshire is 40 bushels, which cannot average less than a Ton weight or 2240 lbs, whilst the load of wheat in Lancashire is only 320 lbs. The Middlesex Load of Straw and of old Hay consists of 36 Trusses of 56 pounds each, amounting to 2016 pounds, but in new hay each truss is expected to weigh four pounds more, making the load amount to 2160 lbs.

(202) Almost every other term used relating to weight, excepting those included in the common elementary Table of Avoirdupois Weight, is equally indefinite. The legal Sack of Wool was stated for example to be 364 pounds: that of Flour is 280 pounds: the customary sack of Pota-

tos in Surrey is 180 pounds. Farther examples would be superfluous.

(203) In like manner "the Last," an Anglo-Saxon word equivalent to Load or burthen, means different quantities of every commodity, in the weighing or packing of which it has been employed. The same remark applies to the Wey, nor have even those weights, which may be considered national or standard weights, altogether escaped from this uncertainty, the legal Hundredweight of 112 pounds having swollen in many districts, into a long hundredweight of 120 pounds, and even the Ton having in some districts increased from 2240 to 2400 or 2500 pounds, or upwards. I again repeat, that it is absolutely impossible for any person in common life to make himself master of such a complex and discordant system.

(204) These incongruities have arisen partly from the natural tendency of weights and measures to increase in a rude state of society, and partly from every varying package, such as the barrel, sack, cask, tub, &c, and every varying load of ass, horse, cart, or wagon, which were originally adopted to suit local habits or circumstances, having been made denominations of weight, and continued as such. Since the periods, when these perplexing terms originated, roads have been multiplied and improved, canals cut, and recently railways formed for steam carriages, whilst steam navigation has come into general use: and all these improvements combined, whilst they have increased the internal commerce of the country in a prodigious degree, have proved the necessity of a thorough revision of that absurd and incongruous system of weights and measures, by which it is still embarrassed. This is so far understood, that in order to prevent their readers from being misled, by the indefinite nature of the denominations of weight in common use, great care is taken by the Editors of the Commercial and Agricultural Papers, published in this country, in stating the price of any article by the stone, never to use the word stone indefinitely, but to specify the stone of 8 pounds, of 14 pounds, or of 16 pounds, &c, &c, respectively, according to the custom of the particular market, to which such report applies: and this is never omitted even in the Reports of meat sold at Smithfield or Newgate markets, although none but the stone of 8 lbs. is ever used for the sale of meat in London. If such specification were not made, it would be impossible for any person to judge of a quantity expressed by the words stone, load, &c, except in his own immediate neighbourhood.

(205) Besides the Statute English weights, and the numerous discordant local weights already alluded to, which are generally multiples of the Avoirdupois pound, the following peculiar weights are used for the valuation of Jewels and Gold.

(206) *Of Pearl Weight.*

Pearls are weighed by Troy weight, excepting that the Pennyweight contains 30 grains instead of 24. Hence the Table of Pearl Weight is as follows.

30 Pearl Grains .....1 Pennyweight.
20 Pennyweights, or 600 Pearl Grains .1 Ounce.

(207) *Of Diamond Weight.*

Diamonds are weighed by Carats, of which 151½ are equal to one ounce of Troy weight. Hence one Diamond Carat is nearly but not exactly equal to 3 grains and one-sixth part of a grain of Troy weight. Each Diamond Carat is divided by the binary mode into halves, quarters, eighths, sixteenths, &c.

(208) *Of the Weight used in estimating the quantity of pure Metal, and of Alloy in Gold Coin or Plate.*

4 Carat Grains .....1 Carat.
24 Carats .....1 Carat Pound.

The Carat Pound is only equal to half an ounce of Troy weight, being the twenty-fourth part of the Troy pound. The Carat itself is therefore equal to 10 grains of Troy weight, and each Carat grain is equal to 2 grains and a half Troy.

In expressing the fineness of gold by this weight, it is stated only in carats, in reference to the carat pound understood. Thus for example, the fineness of the standard gold coin of this country is said to be 22 carats, which implies that there are 22 carats of pure gold, and consequently 2 carats of alloy, or of some inferior metal, in the carat pound.

(209) Upon these three last kinds of weight, it may be remarked, that the use of a pearl grain different from the common Troy grain is to be reprobated; that a special weight for diamonds, different from that by which gold and silver are weighed, appears to be perfectly unnecessary; and that the employment of another special weight, namely the Carat Pound, and its parts, for measuring the quantity of pure metal, and of alloy in gold coin or plate, is not only unnecessary but perfectly absurd; since those quan-

tities ought to have been stated simply as proportions, and not as weights. If the traffic in pearls and diamonds, and the assay of gold, were of daily occurrence in the common business of life, which is not the case, these discordant carats, pounds and grains, all meaning different quantities, would occasion the greatest confusion. But however rare the use of those weights may be, the advantages of simplifying them will scarcely be disputed.

(210) The fineness of silver coin or plate is expressed in ounces and pennyweights, in reference to the Troy pound. Thus for example, the fineness of the standard silver coin of this country is said to be 11 ounces 2 pennyweights, which implies that there are 11 ounces and 2 pennyweights of pure silver, and 18 pennyweights of alloy, in the Troy pound of 12 ounces. Even this mode is deficient in simplicity.

(211) In order to place the complexity and incongruity of our existing weights in a more conspicuous point of view, I have drawn up the two following Tables, first of English weights not exceeding one pound Avoirdupois, and secondly of English weights of one pound Avoirdupois and upwards. In these two Tables it will be observed, that there are a great number of weights which do not appear in the common elementary Tables given in Articles 191, 192 and 193; of which all under one pound have been taken from the second Edition of Dr. Kelly's Universal Cambist,* whilst all exceeding one pound have been extracted from the Appendix to the second Report of the Royal Commissioners on Weights and Measures printed in 1820. In this Document a vast number of customary or local weights and measures have been described, which from not being conversant with agricultural or commercial pursuits, when I commenced this work, I supposed to have been generally superseded by the imperial weights and measures recommended by those Commissioners, and soon after established by law; instead of which in the course of my inquiries I ascertained personally, that many of them are still in common use, and judging by analogy, and from reports of the practice in several parts of England, either obtained from newspapers or in conversation, I have every reason to believe, that the greater part if not the whole of those cus-

* I have omitted the Periot and Blank of Troy weight, stated by Dr. Kelly as subdivisions of the Troy grain, but not the scruple and grain stated by the same Author as subdivisions of the Dram Avoirdupois, because the two latter, although useless and absurd, are not like the former, what may be termed impossible quantities, one if not both of which would be invisible to the eye, and impalpable to the touch of man.

tomary weights and measures are still in use. Hence I thought it right in the following Tables to introduce not only the Statute or Standard weights, but others fixed by various Acts of Parliament, not yet repealed, which I have generally marked legal, and also most of the local or customary weights of England and Wales.

If I had followed the same course in a former part of this work, by adding the principal customary and local measures of capacity to the General Table of Statute English Measures of that description in Article 117, it would have increased that complex Table to more than twice its actual size.

(212) TABLE OF ENGLISH WEIGHTS, NOT EXCEEDING ONE POUND AVOIRDUPOIS, REDUCED TO THE STANDARD OF TROY GRAINS, AND DECIMAL PARTS OF A GRAIN.

	Grains.
1 Doit, Troy weight	0·0021
1-512th part of a Carat, Diamond weight	0·0062
1-64th part of ditto	0·0495
1 Mite, Troy weight	0·05
1-8th part of a Carat, Diamond weight	0·396
1 Grain, Avoirdupois	0·4557
1 Grain, Pearl weight	0·8
1 Carat Grain, for valuing Gold Coinage	2·5
1 Carat, Diamond weight	3·1683
1 Scruple, Avoirdupois	9·114
1 Carat for valuing Gold Coinage	10·0
1 Scruple, Apothecary's weight	20·0
1 Pennyweight, Troy	24·0
1 Dram, Avoirdupois	27·3438
1 Dram, Apothecary's weight	60·0
1 Carat Pound for valuing Gold Coinage	240·0
1 Ounce Avoirdupois	437·5
1 Ounce, Troy and Apothecary's weight	480·0
1 Pound, Troy and Apothecary's weight	5760·0
1 Pound, Avoirdupois	7000·0

(213) TABLE OF ENGLISH WEIGHTS EXCEEDING ONE POUND, INCLUDING LOCAL OR CUSTOMARY WEIGHTS, REDUCED TO THE STANDARD OF AVOIRDUPOIS POUNDS, AND DECIMAL PARTS OF A POUND.

	lb.
1 Standard Pound, of 16 Ounces Avoirdupois	1·0
1 Market Pound of Butter, in part of Buckinghamshire, and in Shropshire, 17 oz	1·0625

1	Market pound in Cheshire, Cornwall, Devonshire, part of Dorsetshire, and of Gloucestershire, Herefordshire, Lancashire, at Louth in Lincolnshire, and at Wolverhampton Staffordshire, 18 oz.	lbs. 1·125
1	Ditto, in the West Riding of Yorkshire, 20 oz.	1·25
1	Ditto, in North Wales, 18 to 21 ounces, lb, 1·25..to..	1·667
1	Pound of Husks or Nuts legal, 21 oz.....	1·667
1	Market pound, in Westmoreland, 12, 16, 18, 20 and 21 oz..lb, 0·75, 1·0, 1·125, 1·25, and	1·667
1	Ditto, in part of Durham, 22 oz.....	1·375
1	Ditto, in the North Riding of Yorkshire, 16 to 24 oz. .....lb, 1·0 to	1·5
1	Ditto, in South Wales, 17, 18, and 24 oz. lb, 1·0625, 1·125, and	1·5
1	Ditto at Stockton Durham, 24 oz.	1·5
1	Pound of Raw Silk, legal, ditto.	
1	Market Stone of Wool, in part of Wales ..	4
1	Ditto, in other Markets of Wales	5
1	Stone of Glass.....	
1	Market Stone of Wool, in part of Wales ..	6
1	Clove of Wool or Cheese	7
1	Market Stone of Wool, in part of Wales	
1	Stone of Meat in London, and in the South of England generally.....	8
1	Clove of Cheese, sometimes.....	
1	Market Stone of Wool, in part of Wales	11
1	Stone of Lead.....	12
1	Stone of Meat, in South Wales, commonly	
1	Stone of Wool, in Gloucestershire	12·5
1	Market Stone of Wool, in part of Wales	13
1	Stone of Alum	13·5
1	Stone of Jockey's weight, the customary Stone in the South of England, except for Meat, Glass, or Lead.....	14
1	Market Stone of Wool, in part of Wales	
1	Stone of Meat in Bedfordshire, north of the River Ouse.....	
1	Market Stone of Wool, the largest of many used in North Wales	15
1	Stone of Wool, including 1 lb. of ingrain, as sold to Wool Staplers in S. Wales	
1	Stone of Hemp, or Flax, legal	16
1	Market Stone of Hay, Tallow, Wool, or Yarn, and sometimes of Meat in Cumberland	

	lb.
1 Market Stone of Wool, in Yorkshire	16½
1 Ditto, in the Western, and in part of the Eastern Moorlands of Yorkshire .. 17 to	17½
1 Ditto, at Darlington, Durham, and in part of Northumberland	18
1 Ditto, in part of the Eastern Moorlands of Yorkshire	19
1 Stone of Meat, in part of Westmoreland, from 14 and 16 to	20
1 Stone of Butter in Westmoreland, 16 lbs. of 20 oz. each	20
1 Stone of Goods generally, at Liverpool	
1 Market Stone of Wool, in part of S. Wales	21
1 Market Stone of Wool, in other parts of S. Wales	22
1 Stone of Wheat, in the West Riding of Yorkshire	
1 Stone of Wool in part of Northumberland, and in some markets of South Wales ..	24
1 Market Stone of Wool, the largest of many used in South Wales	26
1 Quarter of a hundred weight, standard	28
1 Tod of Wool, legal.....	
1 Tod of Wool in Gloucestershire, and in Holderness, Yorkshire	28½
1 Ditto, Bedfordshire, sometimes 28, and sometimes 1 lb. over	29
1 Wey of Wool, Dorsetshire, 30 lbs. to	31
1 Stone of Wool, Guernsey or Jersey..	32
1 Stone of Hemp, sometimes	
1 Pack of Lamb's Wool in Yorkshire and Lancashire	44
1 Truss of Old Hay, or of Straw, legal	56
1 Truss of New Hay, legal	60
1 Tub of Butter, legal	84
1 Barrel of Gunpowder for the King's Service	90
1 Barrel of Gunpowder, legal	
1 Hundredweight in part of Lancashire..	
1 Hundredweight of Aloes, Angelica, Annotto, Assafœtida, Bugle, Camboge, Capers, Cotton, Down, Gentian, Ginseng, Gum, Copal, Gum Guaiacum, Indigo, Isinglass, Manna, Myrrh, long Pepper, Pimento, Plums, Saccharine, Saturni, Sarsaparilla, Tobacco, Turmeric, Verdigris, and raw Linen Yarn, legal	100

	lb.
1 Barrel of Butter, in Essex	106
1 Hundredweight, standard 1 Kilderkin of Butter, neat 1 Barrel of Raisins, legal	112
1 Hundredweight of Cheese at Bridgnorth, Shropshire	113
1 Hundredweight, usually called the long hundredweight, for Cheese in Cambridgeshire, Cheshire, Derbyshire and Leicestershire, and at Wolverhampton Staffordshire; for Hay, in Cheshire and Derbyshire; for Coals in Derbyshire and in part of Shropshire; for Potatos in Essex, and for goods generally in part of Lancashire: also 1 hundredweight of Yarn, legal 1 Barrel of Candles, legal 1 Pocket of Wool	120
1 Hundredweight of Cheese at Shrewsbury	121
1 Bag of Wheat and Potatos (1½ cwt.) 1 Pocket of Hops, in Kent and Surrey 1 Sack of Coals in Devonshire	140
1 Barrel of Butter, Suffolk	156
1 Pig of Lead, Northumberland (1¾ cwt.)	168
1 Load of Lead, sometimes	175
1 Sack of Potatos in Surrey	180
1 Wey of Wool	182
1 Load of Potatos, Lancaster (2 cwt.) 1 Corf of Coals, Derbyshire 1 Wey of Cheese 1 Cask of Wheat Flour 1 Barrel of Butter, of Barilla, or of Potash	224
1 Bag of Spanish Wool 1 Pack of Wool in Huntingdonshire 1 Ditto of Lamb's Wool in North Wales. 1 Ditto of Flax in Kent 1 Load of Oatmeal in Cheshire	240
1 Load of washed Potatos at Ulverstone, Lancashire	250
1 Wey of Cheese in Essex 1 Barrel of Soap, legal	256
1 Load of unwashed Potatos at Ulverstone (13 score)	260
1 Sack of Meal or Flour, legal (2¾ cwt.)	280
1 Sack of Cloves, Mace or Nutmegs, neat weight, legal	300

	lb.
1 Pig of Lead	301
1 Load of Wheat at Ulverstone	320
1 Wey of Cheese in Suffolk (3 cwt.) 1 Cask of Almonds, legal 1 Bag of Ditto	336
1 Pig of Lead at the smelting house, Derbyshire	352½
1 Sack of Wool (3½ cwt.) 1 Corf of Coals, Durham	364
1 Wey of Cheese in Essex, sometimes	416
1 Cask of Tobacco, legal, to be at least	450
1 Bing of Lead Ore, in Durham and Northumberland (8 cwt.)	896
1 Ton of Lime, in North Wales (12 cwt.)	1,344
1 Last of Feathers and Flax	1,700
1 Ton of Culm in South Wales (17 cwt.)	1,904
1 Load of old Hay, or of Straw, 36 Trusses of 56 lbs, Middlesex (18 cwt.)	2,016
1 Load of new Hay, 36 Trusses of 60 lbs, Middlesex	2,160
1 Fodder of Lead with Plumbers	2,184
1 Ton, standard 1 Fodder or Ton of Lead 1 Wey of Salt	2,240
1 Fodder of Pig Lead, in Northumberland (21 cwt.)	2,352
1 Ton of Bark, Gypsum and Lime, of Coals on Canals, and of Dung, Hay, Lead Ore and Straw in part of Derbyshire	2,400
1 Fodder of Derbyshire Lead, shipped at Stockton on Trent (21½ cwt.)	2,408
1 Ditto at Newcastle, sometimes 22 cwt.	2,464
1 Fodder of Lead with Miners (22½ cwt.) 1 Ton of Potatos in Essex 1 Load of Straw, in Oxfordshire	2,520
1 Ton of Coals in North Wales (24 cwt.)	2,688
1 Mill Fodder of Lead at the smelting houses in Derbyshire	2,820
1 Wey of Meal or Flour, legal (36 cwt.)	4,032
1 Last of Wool (42 cwt.)	4,704
1 Newcastle Chaldron of Coals (53 cwt.)	5,936
1 Wey of Coals, South Wales (8 Tons 2 cwt.)	18,144
1 Ditto of refuse Coal, at Swansea (about 9½ Tons)	21,280
1 Ditto of Culm at Swansea (10 Tons)	22,400
1 Newcastle Keel of Coals	47,488

OBSERVATIONS ON THE WEIGHTS AND MEASURES OF SCOTLAND.

(214) I have hitherto abstained from noticing the system prevailing in Scotland, where, in all probability, the standard weights and measures, and even the coins were originally the same as those of the Anglo-Saxons; but which in process of time had been so much altered, that at the close of the sixteenth century, all excepting the standard foot of lineal measure differed widely from those of England; the changes from the original common standards having been carried to a greater extent, in the former than in the latter country. The state of the measures and weights of Scotland was investigated by Parliamentary Commissioners appointed in 1617, who were invested with power to fix them with greater accuracy and to render them uniform, on general principles laid down for their guidance. The standards, recommended by these Commissioners in 1618, were afterwards confirmed by an Act of the Scottish Parliament in 1623. The system of weights established by them, namely, 16 drops 1 ounce, 16 ounces 1 pound, and 16 pounds 1 stone, was sufficiently simple for memory, but very inconvenient and troublesome in calculation. The pound chosen was the French Troyes pound weight, which has generally been considered equal to 17½ ounces Avoirdupois, or to 7656¼ grains of English Troy weight. The Linlithgow Firlot of that age, which by a remarkable coincidence differed only by about three cubic inches in defect, from the present imperial bushel recently established, was made the unit of wheat measure; but unfortunately these Commissioners, who saw the propriety of abolishing heaped measure, by which oats and bear, or bigg, and barley, had hitherto been sold in Scotland, established a second firlot of barley measure, equal to the average contents of the former firlot heaped. Thus two legal firlots, both of *straick*, that is of stricken, measure, were established, one for wheat, rye, peas, beans, meal, seeds and salt, and another for oats, bigg, barley and malt, the latter of which exceeded the former by nearly one half. And as each firlot had its parts the peck and lippie, and its multiples the boll and chalder, this arrangement established a double set of legal corn measures, differing from each other, although bearing the same names, than which it is scarcely possible to conceive any thing more perplexing. But whether these laws were judicious or not, was of very little importance, for the legal pound and

stone then established were never able to supplant the multifarious pounds and stones of *Tron Weight* or customary weight, which generally exceeded the former, but in the most irregular proportions, and which differed in every district; and the numerous customary firlots, bolls, &c, used in the various corn markets of Scotland differed no less from the Linlithgow standard, which those laws vainly attempted to establish.* And in respect to weight in particular, the weights of Holland, which were nearly identical with the French Troyes weight, and those of England which differed considerably from it, had in several parts of Scotland been adopted for the sale of goods imported from those countries, in addition to the multiplicity of Tron weights before mentioned. Hence it was almost impossible for any wholesale dealer in Scotland to sell his commodities by the same measure or weight, by which he purchased them, unless his traffic was confined to one single market or district.

(215) In the Act of Union of the two Kingdoms in 1707, one clause decreed, that the legal measures and weights of England should be adopted for the whole United Kingdom; and that standards should be sent from the Royal Exchequer in London to the several Burghs in Scotland, which by a curious arrangement had the charge, one of one standard measure, or weight, another of another; and which were so situated, that a person who was desirous of examining all the original standards with mathematical accuracy, could not effect this object, without making the tour of Scotland.† The Municipal Authorities of the Scottish

* Both in wheat, and in bear or barley measure, 4 lippies made 1 peck, 4 pecks 1 firlot, 4 firlots 1 boll, and 16 bolls 1 chalder. The wheat firlot or old Linlithgow firlot measured 2215 27 English cubic inches, whilst the barley firlot measured 3231·068 English cubic inches. I extract these values from a pamphlet upon the old measures and weights of Scotland, published in 1829, and supposed to have been written by Mr. John Wilson of Thornly, one of the Directors of the Chamber of Commerce of Glasgow.

† The standard ell was kept at Edinburgh, the standard reel at Perth, the standard pound at Lanark, the standard firlot at Linlithgow, and the standard pint jug at Stirling; but duplicates of all were kept in the castles of Edinburgh, and of Dumbarton. The connection between the standard measures and weights of Scotland was so arranged that the wheat firlot was to measure 19$\frac{1}{6}$ Scottish inches in diameter and 7$\frac{1}{3}$ inches in depth, and was to contain 21 pints and a mutchkin or quarter of the Stirling pint jug, whose capacity was to be measured by 3 pounds and 7 ounces of clear running water from the river of Leith. The barley firlot was to contain 31 Stirling pints, and its diameter and depth were also fixed, but so carelessly, that the proportions between the two firlots, deduced from weight of water, and from measurement, although stated in the same law, were not exactly alike. The Stirling pint jug contained about 104$\frac{1}{4}$ English cubic inches.

Burghs alluded to, were not a little surprised, on examining the new standards, received from the English Exchequer, to discover, that scarcely any two of them were correct parts or multiples of each other; so great had been the neglect of the responsible officers in London, previously to and at that period; and those standards, such as they were, shared the fate of the original Scottish standards of 1618; that is to say, they were never adopted at all, except partially and not by the influence of law, in those places only, which were so intimately connected with England by commerce, that it was a matter of convenience to use them. In fact even the very circumstance, of the abolition of the ancient measures and weights of Scotland, seems so far to have been forgotten, that in the Reign of King George the Second, an Act was passed, prohibiting the sale of certain seeds in Scotland, by any other measure than the Linlithgow firlot, and still more recently in 1791, the Court of Session in Edinburgh pronounced a judgment, directing the use of the two Scottish firlots of 1618 to be strictly inforced, notwithstanding the entire repeal of all the old measures and weights of Scotland by the Act of Union. And in like manner, the celebrated Stirling jug or legal pint of Scotland, which was nearly equal to two quarts of English wine measure, and which was the occasion of many ludicrous mistakes on the part of travellers first visiting that country, maintained its ground long after the Union, in defiance of the pigmy pints of the Sister Country. If this has subsequently become obsolete as a wine measure, although not for all liquids, most of the other customary measures of Scotland have still been retained to the present day, to the great embarrassment of the internal commerce of that country, as will be seen by a reference to the successive Edinburgh Royal Calendars, for many years past, in which several closely printed pages have always been filled with Tables of those measures, in order to enable the Corn Merchants of different Districts of Scotland to understand each other, which without such Tables would be absolutely impossible.

On carefully tracing the history of the measures and weights of Scotland for more than two centuries back, I cannot discover, that the successive laws for regulating them during this period, whether enacted by the Parliament of Scotland, or by that of the United Kingdom, were ever attended to at all, by any class of men, excepting Revenue Officers in the execution of their duty; or that they produced any effect whatsoever, but that of furnishing litigious persons

with grounds for entering into lawsuits with each other, from time to time. To recapitulate, the measures and weights of Scotland, at the commencement of the seventeenth century, appear to have been a chaos, which by the abortive attempts to improve them in 1618 and in 1707, became confusion worse confounded, and upon which the laws of 1824 and 1825 have as yet produced very little effect, if any.*

OBSERVATIONS ON THE CAUSE OF THE GREAT MULTIPLICITY OF WEIGHTS AND MEASURES, IN GREAT BRITAIN.

(216) The cause of this remarkable multiplicity of weights and measures, both in England and in Scotland, shall now be considered. I before remarked, that the natural tendency of weights and measures in a rude state of society is continually to increase, instead of being diminished through fraud, as has usually been supposed. The history of France, England and Scotland, sufficiently proves this fact. In all those countries, the several standard money pounds, being fixed by the practice of the coinage, remained at 12 ounces, like the ancient Roman pound, from which no doubt they were derived; whilst the standard commercial pound increased to 15 ounces amongst the Anglo-Saxons, and to 16 ounces in France and Scotland; and in these two countries the system was better and simpler than that afterwards adopted in England, in the Reigns of Henry the Seventh and Eighth; inasmuch as the French and Scottish ounces both of money weight and of commercial weight were identical, whereas the English Troy pound not only differs from the Avoirdupois pound, but the English Troy ounce differs from the Avoirdupois ounce. The cause of this continual increase may appear sufficiently evident on a little reflection. In market dealings, where values are continually fluctuating, it is well known, that the seller frequently tempts the buyer to purchase a larger quantity than he first demands, by offering him some advantage. This may be done in two ways. He may either offer the buyer a discount on the price, or he may offer to give him one ounce more to the pound, on condition of his purchasing a larger quantity. The latter mode is of course the most advantageous to the dealer, as it enables him to get rid of his stock sooner, by a further increase of the quantity sold, instead of a diminution of price. For example, it is evidently more advantageous to a dealer, in selling butter at one shilling a pound, to offer to his cus

* See the Jury Verdicts or Official Reports of the actual state of the Weights and Measures of Scotland in 1824 and 1825, which are given in a very comprehensive book of Tables for the conversion of those weights and measures into the Imperial standards, published in Edinburgh in 1830, by Mr. George Buchanan, Civil Engineer.

tomer to give him five pounds of butter over, if he will buy 100 pounds weight of that article; than to charge him less than 100 shillings for the 100 pounds weight, by granting him a discount upon that sum, in the like proportion. Hence after plentiful crops in particular, it is natural that the Farmer should offer a larger pound, or a larger bushel than usual, for the same sum of money as before, in preference to lowering the price of his commodities per pound, or per bushel. By this process the pound weight of 12 ounces gradually increased to a larger quantity, in consequence of each extra ounce, added from time to time in years of plenty, becoming after a certain period amalgamated with the original pound. The inconvenience of such uncertainty, although little felt by those individuals, whose dealings were confined to one market or district, caused the Governments of France, England and Scotland, to attempt to fix the Commercial pound, thus gradually increasing, which had become too firmly rooted to be abolished altogether, at the standard of 16 ounces; in spite of which the Customary pounds of England, and the Tron pounds of Scotland, increased in some markets to no less than 24, 26 and even 28 ounces: and I have no doubt, but that a similar increase took place in the customary or local weights of France, if they could be traced, which it would be superfluous for me to attempt. By the same process the hundredweight, originally only 100 pounds, was increased to the standard English hundredweight of 112 pounds, and from thence in many districts to the long hundredweight of 120 pounds; whilst the dozen, score and hundred, of goods sold by tale, ceased to denote 12, 20, and 100, by swelling respectively into long dozens, long scores, and long hundreds; and hence also the customary bushel increased from its original value in most parts of England, and in some, it even swelled out into three times that quantity, as stated in Article 109.* Lineal Measure, on the contrary, is not so liable to vary, being too intimately connected with the stature of men, which in a rude age is a subject of personal importance. A man, who on attaining his full growth, measured 6 feet in height for example, would not willingly allow an

* In inquiring into the history of the measures and weights of this country, I had previously observed as a curious circumstance, that all of them had increased beyond their original standards, excepting those of lineal measure. Mr. Rickman, Clerk to the House of Commons, first drew my attention to the cause of this their tendency to increase, in a rude state of society, which he had previously explained in an able paper on English Weights and Measures, published in 1801, in one of the numbers of the Commercial and Agricultural Magazine.

increased standard of his national lineal measure to be adopted, such as might apparently reduce him to the height of 5 feet 9 inches.

(217) So far as weight is concerned, instead of the useless and embarrassing multiplicity of weights still prevailing in England as stated in Articles 212 and 213, and in Scotland as alluded to in Articles 214 and 215, I propose that there shall be only one pound, and one grain; that these two shall be the only denominations of weight used; and that their respective values and subdivisions shall be as follows.

PROPOSED NEW TABLE OF WEIGHTS.

7000 Grains, or
10 Tenth parts } .....1 Pound.

The Pound to be exactly one sixty-fifth part of the weight of the new cubic foot of distilled water, when the thermometer stands at 18 degrees of the centesimal scale, and the barometer at 24½ digits of the new measure, as was before mentioned (in Article 125).

(218) The grain to be the only division of the pound used for the precious metals, jewels, medical prescriptions, and chemical experiments; and to be subdivided decimally into tenths, and hundredths for very delicate purposes. In short it is proposed, that the pound combined with the grain if necessary, or in smaller quantities the grain alone, shall be used for all those purposes, to which Troy weight, and Apothecary's weight are now applied, and to the exclusion also of Pearl weight, Diamond weight, and all the Carat weights.

Adopting this arrangement, gold and silver bullion, now priced by the ounce Troy, may be priced by the pound weight of 7000 grains, whilst in the retail dealings of Jewellers, more precious articles may be priced by the hundred or by the thousand grains: and this last arrangement may also be adopted by Chemists and Druggists, in the retail of the more valuable articles sold by them in small quantities.

(219) The tenth part of the pound, subdivided by the binary mode into halves, quarters, and eighths, to be used in combination with the pound, if necessary, for the common retail purposes of commerce. The pound itself to be used exclusively for all wholesale commercial transactions.

(220) As I calculate, that the new cubic foot of distilled water would weigh exactly 64·7065 lbs. of our present Avoirdupois weight, or 64 pounds 11⅓ ounces Avoirdupois nearly, it follows that the new pound will only differ from the present standard Avoirdupois pound, by rather less

than 1-220th part in defect, inasmuch as 221 pounds of the new weight will be nearly equal to 220 pounds Avoirdupois. Moreover, as there are exactly 7000 grains of Troy weight in the present Avoirdupois pound, and as I propose that there shall also be 7000 grains of the new weight in the new pound, the proposed new grain will in like manner differ from the present standard Troy grain by the same trifling fraction of about 1-220th part in defect. This difference of weight is so little, that I conceive it impossible for any man to distinguish the new pound from the Avoirdupois pound, by merely lifting them separately, and judging by the comparative pressure on his hand. He would be obliged before he could decide which was the heaviest of the two, to put them into a pair of scales and weigh the one against the other. In comparing smaller quantities, such as a grain or two of the new weight with the present Troy weight, the difference will be almost imperceptible, even by weighing.

By combining a grain differing so very little from the present Troy grain, with a pound differing so very little from the present Avoirdupois pound, into the new and simplified system of weights above proposed, men of all trades and professions will be sufficiently accommodated.

(221) For example, in all Physicians' prescriptions, the grain is the unit, and in by far the greater part of such prescriptions the total quantity of medicines to be made up seldom exceeds two or three hundred grains. Hence the simplified system of weights proposed by me, when a little familiar by use, will save the medical profession a great deal of trouble. Indeed it is so very embarrassing to use a multiplicity of denominations, that the scientific Chemists of this country, some of the most distinguished of whom have belonged to the medical profession, have rejected the ounce, dram and scruple of the Apothecaries, as well as the ounce and the pennyweight of the Jewellers, and have adopted a system of working with grains exclusively in all their analytical experiments, in which they use a system of weights, by which they are able to weigh any quantity from the smallest perceptible decimal fraction of a grain to several thousand grains inclusive, the integral weights used being made up by units, tens, hundreds, and thousands of grains. This system they have found by experience to be much less liable to error, and much less troublesome than any other.

The most intelligent Apothecaries and Chemists, whom I have consulted on the subject, agree with me, that the use of one kind of weight only, instead of two, would be of the

greatest advantage to them, as they are often in doubt, whether the pound or ounce Troy, or the pound or ounce Avoirdupois are intended. By the Apothecaries in particular, I have been assured, that even in practising without the intervention of a Physician, they sometimes get confused between these two kinds of weight, both of which they are obliged to use daily in the course of their business. They also admit, that the entire abolition of the ounce, dram and scruple, would be a very great improvement, as a multiplicity of denominations always leads to confusion. This will be evident by referring to books of Pharmacology, in which nothing is more common, that to see such combinations as 1 scruple and 2 grains of one drug directed to be mixed with 1 dram, 2 scruples, and 10 grains of another. I ask any reasonable man, whether it would not be infinitely clearer to direct 22 grains of the former to be mixed with 110 grains of the latter. By this last system, the proportion between the two ingredients is clearly seen. By the former being the common, but by far more complex system, this proportion escapes observation altogether, nor can it be discovered without solving a couple of questions in Arithmetical Reduction.

Although the arrangement thus proposed will certainly greatly simplify the practice of medical prescriptions, and save much trouble to the Apothecary and Chemist, in compounding them, yet if it should be found at first to confuse a Physician, who has been accustomed as it were to think in the present complex nomenclature, he has only to provide himself with a Table of ounces, drams and scruples, reduced to their equivalent number of grains, which might be printed upon a card. When once accustomed to the exclusive use of the grain, the Physician would have the same satisfaction in this system, and give it the same decided preference, which the scientific Chemists before alluded to have done; for assuredly no man who ever weighed by grains would willingly return to the perplexing system of ounces, drams and scruples, or of ounces and pennyweights, which gives infinitely more trouble and is much more liable to error.

(222) Admitting the necessity of having only one pound, instead of two, the propriety of giving the preference as I have done to the avoirdupois pound, or pound of commerce, to which all classes of the community are accustomed in the every day dealings of life, will scarcely be disputed; and the great advantage of making it an exact

aliquot part of the new cubic foot of distilled water, which led to a very small alteration of the present avoirdupois pound will likewise be admitted; but a question may occur, whether it would not be better to adopt a still simpler system, by subdividing the pound entirely by the decimal method, into ten thousand parts, in lieu of grains, for the more delicate purposes now referred to Troy weight or Apothecary's weight; and into tenths and hundredth parts, for the common retail purposes of commerce.

In reply I must admit, that the strictly decimal system alluded to, would undoubtedly be a more perfect system, if men could be divested of all their former habits and reminiscences. But this being impossible, I was apprehensive that a smaller weight differing so much from our present standard Troy grain, would create considerable embarrassment to all persons, who had been accustomed to the use of Troy weight or of Apothecary's weight. In fact it would be a total change of those two weights, whereas the scale proposed by me can scarcely be considered a change, for it retains the grain, by far the most important unit of both, upon which all the higher denominations are founded, and the rejection of those denominations simplifies without subverting.

For example, the Physician who has been in the habit of ordering his prescriptions to be made up by the grain, can have no hesitation in adopting at once the new grain, proposed by me, which only differs from the present Apothecary's grain by an imperceptible fraction; but if the pound were subdivided decimally into 10,000 equal parts, one of these parts would only be about 7-10ths of the present Apothecary's grain, so that I apprehend that no medical man could with satisfaction substitute the same number of these decimal subdivisions of the pound, for the present Apothecary's grain. Hence as this consideration, renders it unadvisable to adopt exclusively the decimal subdivisions of the new pound, it may be remarked that the conversion of grains into pounds by the easy divisor 7000, is next to the decimal arrangement the simplest that could have been suggested. So much for that part of the new system of weights, which is offered in lieu of our present Troy and Apothecary's weights.

(223) Secondly, in the common retail dealings of commerce, it can never be necessary to subdivide the pound into so many as 100 parts. Indeed although I have frequently inquired into this matter, I have never yet met with

a shopkeeper who had any weight less than a quarter of an ounce, or the 64th part of a pound, in his possession; and they have all assured me, that smaller weights would be perfectly useless in their business. As for the dram avoirdupois, which is the sixteenth part of an ounce, or the two hundred and fifty-sixth part of a pound; if this weight were ever used at all in former times, which I doubt, it is certainly quite obsolete now, nor would even its name have been remembered, had it not, like that equally useless and obsolete measure of length, the barleycorn, been perpetuated in the Tables of Weights and Measures contained in the common School Books on Arithmetic.

(224) To consider the natural and usual mode of retail dealing, a person who purchases groceries or other goods in small quantities, will either order a few pounds, or one pound. If he does not require so much, he will either order half a pound, or a quarter of a pound, but he will scarcely think of going lower, unless the article be very expensive, which is seldom the case with groceries, or unless he should himself be short of money. In goods capable of minute division, such as teas, coffee, spices, moist sugar, snuff, &c, the purchaser may always be accommodated with the precise quantity which he desires, and therefore none but aliquot parts of the pound, such as the half or quarter pound, &c, ever require to be weighed. But in other goods such as cheese, loaf sugar, as well as in the purchase of Butcher's meat, the Tradesman cannot always accommodate his customer, with the precise quantity which the latter desires. On being requested to serve out seven pounds of cheese for example, although he may very nearly, he cannot be expected exactly to cut off that quantity. A fraction more or less than seven pounds will be the result of his first attempt; and unless the difference should be very great, which is not likely to occur, the purchaser takes the 6 pounds and a fraction, or the 7 pounds and a fraction, and pays in proportion, instead of requiring the tradesman to make another cut, either from the original piece or from the portion first cut off. Under such circumstances, the accounts of tradesmen necessarily become embarrassed with smaller fractions, which are not always aliquot parts of the pound: but it is not customary to carry these fractions lower than the half ounce or 32nd part of a pound, which is therefore the smallest quantity that ever forms the subject of calculation, or that enters into a Grocer's bills. Indeed it is more usual for the generality of tradesmen to

omit even the half ounce itself, on the principle of giving and taking before explained.

That the quarter ounce, although a weight in common use should give no trouble in calculation, nor even appear in a tradesman's bill, will be understood, from the circumstance that this very small weight never forms part of a compound quantity, nor is it ever used at all, excepting in the sale of the highest priced groceries such as teas, &c, to persons of the labouring class, who do not wish to order so much as half an ounce at any one time; but being priced beforehand by the Grocer, in reference to the value of the pound weight of the same commodity, this small quantity, the quarter ounce, is always paid for in ready money, not as part of a regular account.

(225) In a former part of this work (Article 22), whilst regulating the proper divisions of the new yard of cloth measure, I purposely abstained from using more parts than the custom of trade requires, and accordingly I divided it into tenths, and half tenths only. Having the same principle in view, and considering that the lowest subdivision of the present Avoirdupois weight, commonly used for those dealings which form the subject of accounts, is the half ounce or 32nd part of the pound; whilst the quarter ounce, or 64th part of the pound, is never used but for small ready money purchases; I propose after first dividing the new pound into ten equal parts, to subdivide each tenth into halves, quarters, and eighths, as was before stated; and in the event of this system being adopted, the quarter tenth, or 40th part of the pound, will be the smallest weight, that will ever form the subject of calculation or enter into the regular accounts of tradesmen; and it was before stated, in Article 26, and exemplified in Article 73, how well decimal parts, and quarters, combine together in calculation.

(226) As Groceries and other goods, which form the subject of the common retail dealings of commerce in this country, have always been priced by the pound, and never by the ounce avoirdupois, and as the system of subdivision proposed by me admits of the new pound being halved and quartered, two tenths and a half being one quarter, five tenths being one half, and seven tenths and a half being three quarters of the pound; this system, which possesses all the advantages of the decimal mode of division, whilst it will greatly simplify accounts, will not confuse or perplex the public, for the only change consists in the abolition

of the ounce, which is merely a fraction of the unit of price, and in the introduction of a new fraction of the same unit, equally or rather more intelligible. I have purposely avoided giving any particular name to the new subdivisions of the pound proposed by me. Every one will at once comprehend the quantity or weight expressed by 5 pounds 3 tenths and a quarter, for the fractional part of this quantity explains itself. But if the term ounces were applied to these tenths, with the epithet "imperial" prefixed to distinguish the new from old avoirdupois ounces, the expression 5 pounds 3 imperial ounces and a quarter, by suggesting all at once the old ounce of 16 to the pound, would confuse the mind, and prevent it from forming any precise notion of the quantity intended; because the first idea that would naturally occur, would be to perform the reduction of the new ounces into the old by the rule of three. In short, I have here followed the same system, as in former parts of this Treatise. Whenever the change proposed was a mere modification, or very trifling alteration of an existing measure or weight, I have retained the same name; but when it involved a material alteration, the old name which, if applied to a new and essentially different quantity, could only lead to error and confusion, has been dropped altogether.

(227) In recommending the entire abolition, of all the present numerous and complex denominations of weight exceeding one pound avoirdupois, and that in future all such quantities shall be stated in pounds exclusively, I propose that weighable goods hitherto sold by the stone, hundredweight, or ton, shall in future be sold by the ten pounds, the hundred pounds, and the thousand pounds exclusively: in short that none, but these three simple decimal multiples of the pound, shall ever be used for the pricing of goods by wholesale. On the same principle, I propose that firkins, barrels, and casks, as also bags and sacks, for containing dry goods sold by weight, shall be made to correspond with the proposed decimal multiples of the pound, as nearly as possible, instead of the parts or multiples of the present hundred weight of 112 pounds, or of any other denomination of weight now in common use, not agreeing with the said decimal multiples. In respect to the contents of such packages, the persons who sell them should be peremptorily required, always to express not only the name of the package, but also its actual contents in pounds, instead of stating the firkin, or sack, &c, &c, as an understood quantity of any particular commodity without such specification.

(228) The immense practical advantages that must arise from simplifying the weights of this country, which are at present a perfect chaos, will scarcely be disputed by any person, who will give himself the trouble to think on the subject. My attention was forcibly drawn to it lately, from having some calculations to make relating to Carpentry, in which several quantities of woodwork, first estimated in pounds weight, in reference to their dimensions, and to the specific gravities of oak and fir, were successively to be reduced into quarters, hundred weights and tons. The useless trouble, and the liability to error, arising from such a complex system soon became apparent. Afterwards I had occasion to use very considerable weights, in several successive experiments, to try the strength of materials by breaking them, in which I found that the same system embarrassed the practice of weighing with a degree of difficulty, from which the decimal multiples of the pound would have been entirely exempt. I had previously experienced the advantages of the decimal system of weighing, in the course of numerous experiments in chemical analysis, which I had occasion to try, and in which according to custom, the grain of Troy weight, with its decimal multiples and parts, had been the only denominations of weight employed. The one set of experiments, immediately succeeding the other, placed by contrast the great disadvantages of the present system of English weights, in the strongest possible light.

(229) Here I may remark, that a person entirely unaccustomed to the practice of weighing is a better judge between these two methods, than one who has been employed in weighing goods all his life, and who consequently having obtained great dexterity by constant habit, is insensible of the disadvantages of the very inconvenient multiples of the pound, which form our present scale of avoirdupois weight. Those men, for example, who weigh goods at the Docks*

* The business of weighing at the Docks or Custom House, is generally made extremely easy, by the circumstance of sugar, coffee, and all other commodities imported in any considerable quantity, being always shipped in packages of the same size and kind. Thus for example, if the average weight of each of the packages forming a ship's cargo be 5 hundred weight and 20 pounds, after the first package is weighed, the five hundred weights are left in one scale, and the pounds only are removed. A second package is then put into the other scale, and pounds are added until the weight of this also is ascertained Hence by this process, whilst more than five hundred weight are weighed at each operation, only three or four small weights at the utmost can ever be required to be shifted. It will be evident that this process of weighing in succession a multitude of packages so nearly equal, can afford no practical criterion whatever, of the advantages or disadvantages of any system of weights, which can only be judged of by weighing irregular and unequal quantities.

or Custom House, get through their duty with considerable facility and expedition, in spite of the very awkward multiples of the pound, that they have to work with. And it is to be observed, that in wholesale dealings, which imply goods sold by the ton or hundredweight, no fractions of a pound are ever used, for in weighing such goods the smallest weight employed is half a pound, and whilst every fraction less than the half pound is rejected, all fractions greater than the half pound are estimated as one pound, on the principle of giving and taking before mentioned in Article 44, which saves much time and trouble, and is equally fair for all parties concerned.

(230) Hence as no weights smaller than a pound are ever noticed in such dealings, it is of no consequence to the wholesale British Merchant, or to his customers, whether the pound weight of Commerce be subdivided decimally or by any other mode. But it is of the greatest importance to both, that all but the decimal multiples of the pound shall be entirely abolished; for they not only considerably embarrass the practice of weighing commodities, but they give still greater trouble in estimating their pecuniary value, as will be shown hereafter, by a practical example of the absurd difficulties, with which this system overwhelms the valuation of goods sold by the ton.

(231) Many men may conceive, that to express great weights in pounds exclusively, as I propose, will not give so clear an idea to the mind, as the statement of the same quantity in tons, hundredweights, quarters and pounds. This supposition is natural on a hasty view of the subject, but I conceive it to be quite unfounded. The thing depends entirely upon habit, and undoubtedly such a man, as a Scottish Carrier, who has been accustomed for a great part of his life time, to load his cart daily, with one ton, or three quarters of a ton, according to the strength of his horse, and the state of the road, will have a much clearer notion of a weight expressed in tons than in pounds. But if the ton were abolished, he would soon acquire the same clear and definite idea of one thousand pounds weight, which he now has of the ton; and I maintain that where habit is equal, the weight expressed simply in pounds will be more easily understood, than the same statement expressed in a more complex form, by several different denominations.

As a case in point, it may be natural for an Englishman to suppose that 20,765 lbs. avoirdupois does not give so clear

a notion of quantity, as the same weight when stated as 9 tons, 5 cwt, 1 qr, 17 lbs, avoirdupois. Yet the same man, on reading or hearing of 20,765 pounds sterling, has a just notion of this sum although expressed in single pounds, and from habit he believes, that no other possible mode of stating it could be clearer. Now I maintain, that if the complex statement in tons, &c, be clearer for pounds avoirdupois, it ought to be clearer also as applied to pounds sterling, for the pound sterling was itself originally not a coin, but exactly one pound weight of silver of the Anglo-Saxon or old English money weight. But if an Englishman of the present day be asked, whether a clearer idea of the sum before mentioned, namely £20,765 sterling will be obtained by stating it as 9 tons 5 hundreds 1 quarter and 17 pounds sterling, he will say certainly not. In the former case, namely that of weight, his habits were all in favour of the more complex statement: in the present case, which refers to money, they are all opposed to it; and he may even treat the supposition in question as an absurdity, although in reality there is nothing more ridiculous in calling 2240 pounds sterling a ton sterling, than there is in calling the same number of pounds avoirdupois the ton weight.

(232) Having sufficiently discussed the subject of weights, we will now proceed to the next object of inquiry.

OF THE PRESENT APOTHECARY'S LIQUID MEASURE.

20 Minims .....1 Fluid Scruple.
3 Fluid Scruples..1 Fluid Dram.
8 Fluid Drams....1 Fluid Ounce.
16 Fluid Ounces ..1 Octarius or Pint.

The symbols for the above are as follows, for minims M, for fluid scruples f ℈, for fluid drams f ʒ, for fluid ounces f ℥, and for the pint or octarius, the letter O. The letter f, for fluid, is prefixed to all, excepting the minim and pint, in order to distinguish the scruple, dram, and ounce of fluid or liquid measure, from the like denominations of dry measure, to which the same symbols apply, without the prefix.

(233) The above Table, extracted from the London Pharmacopœia, is according to the present practice of the London and Dublin Physicians, whose octarius is the old English wine pint of 28·875 cubic inches, being the eighth part of the old wine gallon of 231 cubic inches, they not having yet adopted the imperial measure. In Edinburgh the fluid pound, of 12 fluid ounces, denoted by the letters, f lb, is sometimes used in preference to the octarius, by

which system the minim, fluid scruple, fluid dram, fluid ounce and fluid pound, of the Scottish Physicians, are made nearly to correspond with the grain, scruple, dram, ounce and pound of Apothecary's dry weight, at least if the former be estimated in reference to distilled water, for the fluid ounce measure contains about one ounce weight of that liquid; and as all the other fluid measures and corresponding weights are in the same proportion to each other, being equal parts or multiples of the fluid ounce, or of the ounce weight, the former will in like manner contain quantities of distilled water, nearly but not exactly equal to their corresponding denominations of Apothecary's weight, as the former rather exceed the latter.

(234) Such is the regular Apothecary's measure, but in the practice of administering medicine, great laxity prevails, or at least did prevail until very recently, it being the custom of Physicians to order their patients to take so many drops of the more powerful liquid medicines, and to take others by the teaspoon, dessert spoon, or table spoon, as well as by the wine glass, used as measures. Now it may justly be said of the "gutta" or drop, that it is not a measure at all, for the average drop does not even afford any approximation to a fixed quantity. Indeed no two drops of the same liquid, and dropped from the same phial by the same person, are alike, much less if dropped by different persons and from different phials; for those phials which have the largest necks produce the largest drops. In the very same liquid, larger drops are produced in cold weather than in hot. In different liquids, those which are the purest and most volatile or spirituous and of least specific gravity, produce much smaller drops, than those of a different quality, which are more unctuous or of greater specific gravity. Hence the drop, however carefully and skilfully dropped, for there is an art in doing it well, is so unequal, that the average drop of some liquid medicines is nearly three times as large as that of others. In respect to spoons and glasses, every one knows that the size of spoons of the same denomination, as well as of wine glasses, is very variable, fluctuating with the fashion of the times, and that even at the same time scarcely any sets of spoons of the same denomination are alike in different families. To obviate this uncertainty, the minim or sixtieth part of the dram was adopted some years ago, instead of the gutta or drop, and by means of accurate glass measures, any number of minims required can be measured out correctly, which by the system of dropping was impossible.

The minim glass usually contains 1 dram, or 60 minims, and is divided into six principal divisions of 10 minims each, which are graduated from 10 to 60 inclusive, and into half divisions of 5 minims each. Hence as single minims cannot be accurately measured by this glass, a dropping tube, also of glass, of very small diameter, is used to measure 1, 2, 3, 4, or 5 minims, and is graduated at bottom with 5 circular divisions accordingly. This tube being open at both ends, is dipped into any liquid medicine, until it takes in the number of minims required, not exceeding five, after which the finger being applied to close the aperture at top, the pressure of the air prevents the liquid received in the bottom of the tube from dropping out, until it is held over the phial or glass, in which it is to be finally deposited for the use of the patient. Thus the dropping tube and minim glass are the smallest measures used. The next is a two-ounce glass measure, divided on one side into ounces and quarters, and on the other into 16 drams, each of which is usually halved. When the Physician's prescription is taken to the Chemist, he allows for each teaspoon ordered one dram, or the eighth part of an ounce, for each dessert spoon 2 drams or a quarter of an ounce, for each table spoon 4 drams or half an ounce; and for each wine glass he allows the full measure of 2 fluid ounces. For larger quantities a half pint measure is generally used, with two graduated scales, one of which is divided into eight fluid ounces, each ounce being halved and quartered, whilst the other scale, on the opposite side of the glass, is divided into 64 drams. But this accuracy is only observed by the regular Chemists or Apothecaries, who are provided with all the graduated glass measures necessary. Scarcely any persons not belonging to the medical profession have any of these measures, excepting a few individuals, who may be under the necessity of using very powerful liquid medicines frequently, and who therefore provide themselves with the minim glass. Recently glasses graduated by the teaspoon, dessert spoon, or table spoon, have also been made, but are more rarely used. Hence it may be said, that in most families the medicines are administered not by measure, but by guess. It is to be observed however, that no danger can arise to the patient from this circumstance, for the Physician takes care to order all those medicines, which have a powerful effect on the human constitution, to be so copiously diluted before they are administered, that the difference in the size of two spoons in different families may not make a difference of more than

the fraction of a minim, in the quantity of concentrated medicine contained in the dose. On discovering the inaccuracy of this practice, of which I must confess that I was not fully aware, until I inquired into this part of my subject, I consulted several intelligent medical men, who assured me that very slight differences of measure, not exceeding about one part in 20, are of little importance as to the quality of a medicine.

(235) Such being the practice, and such the opinion of medical men on this head, I beg leave to propose the following arrangement, in lieu of the present system.

PROPOSED NEW TABLE OF APOTHECARY'S LIQUID MEASURE.

50 Minims .....1 Tenth of a Digit.
10 Tenths, or 500 Minims ..1 Digit, or Fluid Ounce.
10 Digits .....1 Chopin, or Half Pint.

This new scale, being subdivided decimally in its principal parts, will have the advantage of simplicity over the present system; and as the digit, which implies the cubic digit of the new measure, will differ only by about 1-170th part in defect from the present fluid ounce of the Apothecaries, they may safely be considered equal. It will be observed, that I propose to divide the new fluid ounce into 500 minims, as yielding a simpler proportion, than 480, which prevails in our present Apothecary's liquid measure. This change will cause the new minim to differ by about 1-22nd part in defect from the present minim, which is not of much importance. Hence the Physician, who is accustomed to prescribe by the present system of minims, fluid scruples, fluid drams and fluid ounces, has two points of coincidence, by which he may reduce those measures to the new measures proposed, namely the minim and fluid ounce; but perhaps for some time after the introduction of the new measure, it may be most expedient for him to make use of a card, in which the value of the fluid drams, and fluid scruples, of the old shall be stated in terms of the new.

(236) In respect to quantities greater than the fluid ounce, as the Edinburgh Physicians now use a measure of 12 fluid ounces, whilst the London Physicians use a measure of 16 fluid ounces, and as the former, although nominally a weight, is in reality a measure, and like the latter does not agree with any of our present legal measures, I propose as an improvement upon the practice of both, to use the chopin or half pint of 10 fluid ounces or digits; by the adoption of which, in combination with the cubic digit,

proportional quantities will always be known without the trouble of calculation.

For example, if the Physician should order 8 cubic digits and 3 tenths of any liquid medicine to be mixed with 3 chopins or half pints of water, the proportion will be known at once to be $8\frac{3}{10}$ of the former, to 30 of the latter, or as 83 parts of the medicine to 300 of the water. If the pint itself were used instead of the chopin, this simple proportion would be lost, for in that case, it would be necessary to multiply by 20, in order to reduce pints into digits, which cannot be done with such confidence and facility as the multiplication by 10, which scarcely requires an effort of the mind.

(237) In adopting the new system of Apothecary's liquid measure now under consideration, the following glass measures will be convenient for the determination of quantities.

First, a dropping tube, similar to that before described in Article 234.

Secondly, a small glass containing one tenth of a cubic digit divided into 50 minims, which may be called the minim glass.

Thirdly, a two-digit (or two-ounce) glass, divided into tenths, with each tenth halved and quartered.

Fourthly, a chopin, or half pint glass divided into 10 digits, with each digit halved.

No more graduated glass measures than the above would be necessary, as very minute divisions of large measures can never be accurate, and the Apothecary or Chemist would of course have common pint and quart measures in his possession, by which he could measure great quantities of liquid more expeditiously, than by frequent repetitions with the chopin or half pint.

(238) In addition to the symbols before explained in Article 232, the Physicians use ss. (the contraction of the Latin word Semis) for half. As I propose to subdivide the tenth of the cubic digit into halves and quarters, the contraction qr. may be used for quarter, and ss. qr. for three quarters.

The tenth of the digit being a new quantity must be expressed by a new symbol, for which the capital letter X, of that style of writing which is called round hand, with a bar across the middle of it, thus $\mathfrak{X}$, may be adopted. The same symbol ʒ which denotes the present ounce, might still continue to be used for the cubic digit, these measures being

so nearly equal; but I would prefer using the new symbol or contraction Dg. for digit, to express this quantity, it being of importance, that the connection between measures of length and of capacity should be clearly understood and always kept in view, which will be accomplished by using the word digit common to both, whereas by using the word ounce to express the quantity measured by a cubic digit, we lose sight of this connection altogether.

Ch. the contraction of chopin, may be used to express the half pint.*

To exemplify the use of these new symbols, three digits, six tenths and a half of liquid measure, will be marked thus, Dg. iii. ℨ vi. ss.

Nine digits, one tenth and a quarter, will be marked thus, Dg. ix. ℨ i. qr.

Four tenths of a digit and three quarters, will be marked thus, ℨ iv. ss. qr.

Five chopins or half pints will be marked thus, ch. v.

(239) In concluding this branch of my subject, I cannot help observing, that it appears to me, with deference to that learned Profession, that it would be a simpler method of medical notation, if Physicians would agree to adopt the common Arabian numeral figures, for expressing their quantities, instead of still adhering to the obsolete system of old Roman numeral letters, which has long been disused by men of all other professions, in the transaction of their business. By rejecting the dram weight as I propose, the symbol for which nearly resembles the figure 3, no error or ambiguity can arise from this change, numeral figures being certainly quite as accurate as numeral letters, and no person of education being more likely to misapply the former, than the latter.

OF THE ORIGINAL MONETARY SYSTEM OF ENGLAND. THAT IT WAS IDENTICAL, OR NEARLY SO, WITH THAT WHICH PREVAILED ON THE CONTINENT. REMARKS ON THE SUBSEQUENT CHANGES.

(240) The system of money established towards the close of the eighth century by Charlemagne, was not only used in France, Italy and those parts of Germany, which composed the dominions of that great monarch, but was also

* Chopinus may be used as Apothecary's Latin for the half pint, which although not a classical word, will be more appropriate than the more elegant term, Semioctarius, because the new measure, if adopted, has no gallon, of which measure only the pint can with propriety be termed the octarius.

adopted in Britain and in the Christian part of Spain. All payments were estimated in reference to the *Libra* or pound weight of silver, which was divided into twenty *Solidi*, or shillings, and each shilling into twelve *Denarii*, or pennies. These were the divisions of the pound of money, but for other purposes the same pound was divided into twelve ounces, according to the system of the ancient Romans. Such was the common origin of the *Pound Sterling* of England,* the *Pound* of Scottish money, the *Livre* of France, the *Libra* of Spain, and the *Lira* of some of the States of Italy, all of which were originally equal or nearly so: and the *Marc*, likewise common to all those countries, denoted a weight of 8 ounces, being two thirds of the above pound. Amongst the Anglo-Saxons, and for some time after the Norman Conquest, it appears that there were only two coins in England, the most important, although the smallest of which was the silver penny, which was not only the penny coin but the penny weight of those times, being exactly the two hundred and fortieth part of the pound weight of silver. The second silver coin alluded to was equal to the fifth part of the shilling,† but the shilling itself was not a coin but a weight, and as such, it appears to have been applied to the weighing of bread as well as of money.‡

(241) The beneficial and simple system of absolute identity between weight and silver money, which thus prevailed

* In England the term "Sterling" originally "Easterling," and in France the synonimous term "Esterlin," were used to denote the twentieth part of the ounce, also called "penny" in England and "denier" from denarius in France. This term, whilst it became entirely obsolete in France, was by degrees applied not only to the penny, but to the pound in England, and recently it has been used to denote the standard money of this country, in contradistinction to Foreign or Colonial money. For the use of this term in France, see Paucton's Elaborate Treatise on Metrology, published in Paris in 1780, who observes after stating the Royal or legal system of weights prevailing in France, that the then French pound (Livre de Marc) was anciently divided into 320 esterlins. Hence the pound of Charlemagne of 12 ounces must have been divided into 240 esterlins, and the common ounce of both those pounds must have been divided into 20 esterlins.

† See the 5th Edition of Turner's History of the Anglo-Saxons, vol. 2. Appendix II.

‡ In the document entitled "Assiza Panis et Cervisiæ," or Assize of Bread and Ale, published in the collection of the Statutes of the Realm, and marked of uncertain date, but supposed to have been a Statute of the 51st of Henry the Third, it is declared that "when a quarter of wheat is sold for "eighteen pence, then wastel bread of a farthing, white and well baked, "shall weigh four pounds ten shillings and eight pence," and thus it proceeds giving a progressive scale of prices of wheat; and fixing the assize in proportion, until wheat shall rise to twenty shillings the quarter, when it is declared that the weight of the farthing loaf shall be six shillings and ninepence three farthings.

over a great part of Europe, was not permanent. The standard pound of Commerce, which in all probability was originally only twelve ounces, increased to fifteen ounces amongst the Anglo-Saxons,* and to sixteen in France and Scotland, and eventually in England also; whilst the local or market pounds in many parts of England and of Scotland, and I have no doubt in other parts of Europe also, increased to a much greater magnitude, as was before mentioned in Article 216. I have not been able to discover, at what period the commercial pound of France, called Livre de Marc, and consisting of 2 marcs, or of 16 ounces, came into general use; but it finally supplanted the pound of twelve ounces entirely, having been adopted by the French Physicians in place of an Apothecary's weight similar to ours, after the middle of the eighteenth century, when it was considered the only legal weight in France, excepting that by a curious arrangement, silk was weighed by a pound of fifteen ounces similar to that of the Anglo-Saxons. The aliquot parts of the French Livre de Marc, were rather incongruous, the denier, the carat, &c, being used for money, which were not used for other purposes; but as applied to the wholesale and even to the retail dealings of commerce, the French system of standard weights, before the revolution, possessed great advantages over those of England. It had only one ounce and one pound; and the multiples of the latter were the most convenient that could have been desired, namely the "*Quintal*" or hundredweight of 100 pounds, and the "*Millier*" or thousandweight of 1000 pounds.†

(242) Whilst the original pound, as applied to the ordinary purposes of commerce was generally increasing, the pound, as applied to money, began on the contrary to diminish in a much greater ratio in every part of Europe, as soon as the general use of coins had superseded the practice of making large payments by weight. This was owing to the successive depreciation of the currency of every State, which took place from time to time, when their respective Governments were pressed for

* In Strutt's Chronicle of England, vol. ii, page 233, he states that the Anglo-Saxons, besides their money pound of twelve ounces, had another weight called the mercantile pound or market pound, containing fifteen ounces to the pound, which was obliged to be properly stamped. This fact he deduces from a law of King Ethelred, which he quotes in a note from Brompton. The same system of having two pounds of the above values respectively, was retained long after the Norman Conquest, as will be seen by a reference to several of the earliest laws on the subject of weights and measures, published in the collection of the Statutes of the Realm.

† The French ton of shipping, when estimated by weight, was originally 2000 lbs. Recently the simpler system, of estimating tonnage by their Millier of 1000 lbs, has justly been preferred.

money. Thus for example, the pound sterling of English money, which weighed in standard silver no less than 5400 grains of our present Troy weight, has been reduced to 1745 Troy grains only, as estimated by the weight of four crown pieces of our last silver coinage, being less than one third of its original weight. By the same injurious process, the pound of Scottish money had been so much more depreciated, that at the period of the Union, it was only equal to about 20 pence sterling, of its cotemporary English money, whilst the livre or pound of French money was still farther diminished, being only equal to about 10 pence sterling at the period of the French Revolution. Hence the French *Sous*, originally the solidus, weighing more than half an ounce of silver, had dwindled into a copper coin equivalent to an English halfpenny; and the French *Denier*, the representative of the denarius of Charlemagne, had dwindled into the sixth part of an English farthing, and consequently had become too insignificant to be used as a coin at all. From the more intimate connection between the English and the Scots, and from their speaking dialects of the same language, the diminutive pound of Scottish money naturally became a subject of ridicule in England, from which the livre of France escaped, although still more deserving of it; for certainly nothing could have been more absurd, than to continue to apply the name of livre or pound, to a small piece of silver weighing only about the sixth part of an ounce of that pound, of which it had originally been the fair and equal representative.

(243) The French afterwards got rid of this incongruity, by adopting the word *Franc*, which has no reference to weight, for the unit of their monetary system, instead of the word *Livre*;* and they made a more essential improvement, by abolishing the sous and denier, and subdividing their franc decimally into 10 decimes and 100 centimes. At the same time, they simplified the standards of the gold and silver used in their coinage, by adding a little more alloy to both, and making the proportion of pure metal in each uniform, which they accomplished by using 9 parts of pure gold to 1 part of copper alloy in their gold coinage, and 9 parts of pure silver to 1 part of copper alloy in their silver coinage: and from this period they have ceased to value the

* The present Franc is not exactly although nearly identical with the old Livre Tournois, which it exceeds by one-eightieth part. The word Franc has been known in France as synonymous with Livre for several centuries, but the latter term was not altogether abolished until recently.

purity of their coinage in carats for gold, and deniers for silver,* according to an ancient system equally complex, but not identically the same, with that employed in England for this purpose, as described in Articles 208 and 210. Of all the innovations made by the Revolutionary Governments of France, in matters connected with the subject of this Treatise, the above are the most judicious, if not the only judicious ones. By retaining the franc or livre, which had been the unit of their monetary system for ages, they did no violence to the habits of the French nation, whilst by the simplification of its subdivisions, they introduced improvement without confusion. In every other part of their new system of Metrology, by discarding all the units of measure and of weight, that had become interwoven with the habits, and as it were with the ideas of the people, they completely unsettled their minds, and threw every thing into confusion, as was before observed in Articles 2 and 3.

(244) Besides the wilful depreciation of the currency in every country of modern Europe, arising from the gradual diminution of the weight of coins of the same name, and composed of gold and silver of the same standard, which is a practice not entirely modern, for the same abuse of power was often exercised by the Governments of antiquity ;† another mode has also been occasionally resorted to, of effecting this object, by debasing the standards of the gold and silver bullion used in the coinage with a greater proportion of alloy. This was carried to a great extent in England in the two last years of the reign of King Henry the Eighth, whose silver coins were composed of a mixture of one part of pure silver with two parts of alloy, instead of about eleven of the former to one of the latter, which was the standard of the silver coins of England, before as well as after that period. I made use of the expression "about," because although nearly, this is not exactly the present standard, which consists of 11 ounces 2 pennyweights of pure silver, and 18 pennyweights of alloy, in each pound of 12 ounces. Notwithstanding the antiquity of this standard, which prevailed from the Norman Conquest to the eighteenth year of King Henry the Eighth, and again from the second of Queen

* Formerly the French estimated the purity of their gold by carats, and thirty-second parts of the carat, using 24 carats to represent the whole compound mass of pure metal and alloy; whilst they estimated that of their silver by deniers and twenty-fourth parts of the denier, using twelve deniers to represent the whole compound mass of pure silver and alloy.

† For example, the ancient Roman coin, the As, originally a pound of brass or copper of twelve ounces, was reduced to one-sixth of its original weight, during the first Punic war.

Elizabeth to the present day inclusive, it surely would be better to assimilate the fineness of the gold and silver bullion used in our coinage, as the French have done, by employing the same proportion of alloy in both. In our gold coinage the proportion is eleven parts of gold to one of alloy, which would be sufficiently simple, if divested of the technicality of carats, which only serves to render it unintelligible. In our silver coinage, why not adopt the same simple proportion in future, instead of the present proportion of $11\frac{1}{10}$ ounces of pure silver to $\frac{2}{10}$ths of an ounce of alloy, which is in the ratio of 37 parts of the former to 3 of the latter? By getting rid of this complex proportion, and by adopting 11 parts of pure metal and 1 part of copper alloy, for the common standard both of our gold and silver coinage, we should assimilate both in a simple manner, easy to be understood, and never to be forgotten. But considering that there are many standards of gold and silver bullion, used for various kinds of plate, or ornamental work, and differing from each other, as well as from those used in the coinage, it appears to me, that it will be still better to adopt the system of stating the fineness of gold and silver bullion at so much per cent, which will afford the means of forming a comparative estimate of the value of each kind of standard in use, both for coins and plate, much more readily, than by the use of a vulgar fraction, such as 11-12ths. Should this suggestion be approved, the fineness of the standard of our present gold coins would be stated as $91\frac{2}{3}$ per cent, and that of our present silver coins as $92\frac{1}{2}$ per cent, which are far from being convenient expressions. In this case, therefore, that is with a view to the proposed assimilation of the mode of stating the fineness of all gold and silver bullion, I would recommend the standard both of our silver and of our gold coinage to be altered a little in the next coinage that may take place, by reducing the proportion of pure metal in both to 90 per cent, which would not only simplify those standards, but would render them identical with the standards of the present French coinage. This in itself would perhaps be an advantage of no small importance.

(245) It is to be observed, that until lately it was the custom at the Royal Mint in London, to return an equal weight of coined or minted gold or silver to any person, in exchange for whatever quantity he might be pleased to offer, of gold or silver bullion of the same standard; and it was also the custom at least during a part of the Reign of King George the Third, to assign to the copper coinage no higher

average value, than its own weight of equally pure copper at the time being. Hence the British Government coined money for the public gratuitously, without making any charge of "seignorage," as it is technically termed, to compensate wholly or in part, the expenses of the coinage. From these arrangements, together with the circumstance of the British gold coins having been alloyed with silver, whilst those of France were alloyed with copper, a system was introduced of exporting them to the Continent, and melting them for the purpose of extracting the silver as a commercial speculation; and in respect to our copper coins in particular, Braziers and other artizans were in the habit of melting them, as a matter of convenience, whenever they wished to work with particularly pure copper; and the same temptation existed for persons working in silver to melt our silver coins.

In the last British coinages of gold, silver, and copper, these temptations to melt the coin have been removed. The last gold coinage has been alloyed with copper instead of silver. The pound Troy of standard silver formerly coined into 62 shillings, being the average market price of that quantity, has been recently coined into 66 shillings; and the copper coins, having been still more reduced, are now of much less value to the Brazier than an equal weight of good copper. The gold coins only still retain the same weight in the last, which they did in former British coinages.*

(246) It may be remarked, that the diminution of the weight of copper coins, unless carried so far, as to render the illicit imitation of such coins by unprincipled persons a matter of profitable speculation, is a great advantage to the public. Nothing could be more inconvenient than our copper coins during a part of the Reign of George the Third, when a person who received twelve pence in copper was burthened with a weight of about three quarters of a pound avoirdupois. To obviate this inconvenience, the French use coins of what they call *Billon*, consisting of 2 parts of silver mixed with 8 parts of copper; but this intermediate metal, between their standard silver and copper coins, which they estimate at one fourth of the value of the former, cannot well be distinguished from the latter, either by colour or by weight, and therefore it is not to be recommended for imitation. From what I have seen of the French coinage, the billon is the only objectionable part of it, for no one could tell the difference between the French copper centime, and the billon decime, al-

* The Pound Troy of Standard Gold is coined into 46 Sovereigns and 29-40th parts of a Sovereign. The Pound Avoirdupois of Copper is coined into 24 Pence.

though the latter is ten times the value of the former, if their respective names were not stamped upon each, as is the custom in the French coinage.

(247) Two other causes not yet noticed have affected, and will always continue to affect the value of money hereafter, in every country, even if no further change in the weight or standard of any of the gold or silver coins now in use, should take place. One of these causes, which has been in operation from the earliest ages, is the continual fluctuation of the respective quantities of gold and silver coins, and bullion, in circulation at the same period, as well as of the respective prices of these two metals, depending upon the expense of working the mines, from which they are obtained, &c. Hence the value of gold, as compared with that of an equal quantity of silver, has varied exceedingly both in ancient and in modern times. In the last French coinage, one pound of gold has been made equal to fifteen pounds and a half of silver. In our last British coinage the value of gold has been fixed to that of silver in the proportion of $14\frac{7}{44}$ to 1, or stated decimally as 14·1591 to 1 nearly. Another cause of modern origin, which may affect the value of money in any country perhaps still more than the former, is the proportion of paper money in circulation in addition to the metallic currency. But to enter into these considerations, which are important questions of political economy, farther than merely to notice them, would be superfluous to our subject. I shall therefore proceed, after describing our present national monetary system, to suggest those improvements, which appear desirable.

(248) OF THE PRESENT STATUTE ENGLISH STERLING MONEY.

4 Farthings .....1 Penny.
12 Pence, or 48 Farthings ..1 Shilling.
20 Shillings, 240 Pence, or 960 Farthings..1 Pound.

These proportions between the several denominations of English money have prevailed for many centuries, but the whole as a system, was formerly rendered more complex by the occasional use of gold coins, which were either aliquot parts of the pound sterling not being multiples of the shilling, or multiples of the shilling but not of the pound. Such were the Noble of the fourteenth and Angel of the fifteenth century, each of which was equal to six shillings and eight pence, or to one third of a pound of the then standard; and such

also was the 30 shilling piece of the sixteenth century, and more recently the guinea of 21 shillings, the half guinea of 10 shillings and sixpence, and the third of the guinea or seven-shilling piece.* Our present coins corresponding with the same denominations or system of money are more simple; but both would be greatly improved, by subdividing the pound sterling into tenths, hundredths, and thousandth parts, in the same manner as the Government of the United States of America have subdivided their dollar, and by adopting such new copper and silver coins as shall agree with the proposed new decimal divisions of the pound.

(249) PROPOSED NEW SYSTEM OF STERLING MONEY.

10 Tythings.....1 Cent.
10 Cents .....1 Tenth of a Pound.
100 Cents, or 10 Tenths ....1 Pound Sterling.

The copper coins most appropriate to this new monetary system will be as follows.

1st. The 1 TYTHING copper coin.
2dly. The 2 TYTHINGS copper coin.

These two new copper coins may be made of the same size and weight respectively, as the farthing and halfpenny of our present coinage, from which they will differ in legal value by one twenty-fifth part in defect, in consequence of the pound sterling being made equal to 1000 tythings, instead of 960 farthings. Each of these new copper coins should have its name and value stamped on one side of it, namely 1 TYTHING or $\frac{1}{10}$ CENT upon the smaller, and 2 TYTHINGS or $\frac{1}{5}$ CENT upon the larger of the two. This is absolutely necessary, in order to impress the new nomenclature of the improved coinage upon the minds of the people.

The silver coins most appropriate to the new monetary system proposed will be as follows.

1st. The 1 CENT silver coin.
2d. The 2 CENTS silver coin.
3dly. The 4 CENTS silver coin.

These coins will be respectively equal to two pence four tenths, four pence eight tenths, and nine pence six tenths of our present money: and each of them must also have its value marked on one side of it, for the reason before stated.

* In the first coinage of guineas, in 1663, they were issued as 20 shilling gold pieces. Their legal value was not increased to 21 shillings till long afterwards.

They will respectively be of the same size and appearance nearly, as the quarter-franc, the half-franc, and the one-franc piece, of the present French silver money. The cent will be smaller than any silver coin to which we have been accustomed of late in this country, but not inconveniently so for use; and it will probably be of advantage to men of moderate income, to have three small silver coins of the above value, instead of two only, the present silver sixpence and shilling.

4thly. The 10 CENTS, or 1 TENTH silver coin.
5thly. The 20 CENTS, or 2 TENTHS silver coin.

These two coins also, the former of which will be equal to two shillings, and the latter to four shillings of our present money, should have their new names marked on one side of each.

In respect to our present gold coins, the sovereign or one pound gold piece, and the half sovereign or half pound gold piece, no change will be necessary.

(250) The system, which I have just suggested, of marking the name and value of every new coin on one side of it, was judiciously adopted by the French in 1795, when they permanently established the word *Franc* instead of *Livre*, and abolished all the former subdivisions of this their unit of money. If they had not adopted this judicious arrangement, the terms livre, sous and denier, would never have been got rid of, and the latter denomination in particular, by being in all probability applied at random to the new coins* would have created the same confusion in France, as in the British Colonies, where the coins used are the Spanish dollar with its multiples and parts, which although they have no reference to our English money, have always been valued in these Colonies, by pounds, shillings and pence, and in no two of them alike. The same, if not greater confusion, has been caused in the United States of America, partly from their having tolerated the original binary parts of the Spanish dollar, when they thought proper to make that coin the unit of their monetary system, and partly from their having omitted to mark the new names adopted by them upon all the new coins, which they issued from their own mint, after they had decreed, that the dollar should be subdivided decimally into 10 dimes, 100 cents, and 1000 mills. Hence the American "Dime," although only the tenth part, passes in many of the States for the original Spanish "Real," which is the eighth part of the dollar; and the real itself, al-

* The sous agrees with the half decime of the present French money, to which the denier is altogether inapplicable.

though only equal to sixpence three farthings of sterling money, if the dollar be estimated at four shillings and sixpence, passes in some parts of the United States for a shilling, in others as an eleven-penny, ten-penny, or nine-penny bit.* Such confusion must of course be carefully guarded against, in the event of our making a similar change in the aliquot parts of the pound sterling: and the complete success of the French under the like circumstances, sufficiently recommends the judicious precautions adopted by them for our own imitation.

(251) In the course of this inquiry, it has frequently occurred to me, that it would be a great improvement to abolish the term pound sterling altogether, and to confine the word pound to weight exclusively. And if this suggestion were approved, the term unit sterling would be the most suitable for that which is still improperly termed a pound, after having lost all pretensions to the name. This new term unit would soon be impressed on the minds of the people, by a new coinage consisting of two gold coins equal in value to our present sovereigns and half sovereigns, but having the words UNIT STERLING marked on one side of the one, and ½ UNIT STERLING on the other, combined also with a new issue of Bank Notes, in which the term UNITS STERLING should every where be substituted in place of the word POUNDS: and it is remarkable that one of our old gold coins, of which the value was twenty shillings, was called the unit in the reign of King James the First.† But considering the great inconvenience of having not only an entire new gold coinage, but a complete change of all the paper money of this country; and considering also that we have been in the habit of estimating the fortunes of individuals, as well as the public revenue, and of making all bargains of importance, by the pound sterling from time immemorial; I was apprehensive, that the change now in question might create embarrassment or cause dissatisfaction, and therefore as a thing not absolutely necessary, I have abstained from urging it. I had originally proposed to call the tenth part of

* See the Report of Mr. John Quincy Adams, upon Weights and Measures, printed in Washington in 1821, and prepared in obedience to a resolution of the Senate of the United States of the 3rd of March 1817, he being then Secretary of State, but afterwards he had the honour of being President of the United States.

† The first Units were issued in 1604 or 1605. They ceased to be coined about forty years afterwards. Only 20 shilling pieces at first, they passed afterwards for 22 and subsequently for 25 shillings, and continued in circulation for more than a Century.

the pound sterling, by the term "Decim," but on further reflection I abandoned it, as it occurred to me, that this term might for a long time remain unintelligible to the mass of the people, whereas the expression tenth of a pound explains itself.

(252) If the decimal system of sterling money, recommended in the preceding articles should be adopted, the most convenient mode of stating all accounts will be in pounds, cents and tythings, without noticing the tenth of the pound, otherwise than as a multiple of the cent. In short the tenth of the pound sterling would be a coin used in paying money, but it would not appear in the statement of any sum involving a mixed quantity of pounds and parts of the pound.

For example, instead of stating the decimal expression, 15·763£, as fifteen pounds, seven tenths, six cents and three tythings, I would state it as fifteen pounds, seventy-six cents and three tythings, and I would write it as 15£, 76c, 3*t*. or more simply as 15£, 76·3c.

There can scarcely be a doubt of the advantages of thus stating accounts in pounds, and cents, without using the intermediate denomination, since the French and Americans, who have both used decimal money for nearly half a century, have adopted this system without reference to each other, the French being in the habit of stating all accounts in francs and centimes, and the Americans in dollars and cents; that is in units and hundredth parts only of their respective moneys, without noticing by name either the decime, which is the tenth part of the franc, or the dime, which is the tenth part of the American dollar.

ADVANTAGES OF THE NEW MONETARY SYSTEM PROPOSED.

(253) The advantages of the new denominations of money, founded on the decimal subdivisions of the pound sterling, as combined with the new system of measures and of weights proposed, will be immense, so far as the simplification of accounts is concerned.

For example, if we suppose that a Builder has received from an Iron Founder 215 tons, 17 cwt. 3 qrs. and 9 lbs. of cast iron columns, &c, for which he agreed to pay at the rate of 9£. 11*s*. 6½*d*. per ton, and that the amount is to be computed by our present system of weights and money; this is a most troublesome question in the Rule of Three. The quantity stated in tons and parts of a ton, has to be reduced into pounds avoirdupois, and the price stated in pounds

sterling, and parts of a pound sterling, has to be reduced into farthings: and these two quantities thus reduced must be multiplied together, and the product divided by 2240, the number of pounds weight in one ton; and lastly the quotient has to be reduced from farthings into pounds sterling. Thus the mere pricing of a quantity of cast ironwork involves three troublesome operations in Arithmetical Reduction descending, one in long multiplication, one in long division, and one in Arithmetical Reduction ascending.*

By the new system proposed, the same quantity of ironwork would be stated as 483,597 lbs, which would be charged at the equivalent price of 4·275 £. sterling, per thousandweight. In this case the only operation necessary to find the amount would be to multiply the numbers 483,597 and 4·275 together, which after omitting superfluous decimals yields the answer at once in pounds sterling and decimal parts of the pound. This simple calculation, which consists of only one operation in long multiplication, may be performed in one fourth part of the time, which is required by the former method, and with much less risk of error.

(254) In short so far as price and value are concerned, which necessarily enter into all the accounts of Merchants, Tradesmen and Dealers, the new system of money will be attended with the important advantage of doing away the embarrassing necessity, which so frequently occurs, first to multiply a compound sum of money by 20, 12 and 4, at one period of a calculation, and afterwards by an inverse process, to divide the final quantity found, by 4, 12 and 20 at the close of it.

As a practical example of the inferiority of the present system of weights and money to the new system proposed, I shall subjoin the calculation of the Iron Founder's bill which has just been stated.

(255) *First, by the present English Weights and Money.*

Two hundred and fifteen tons, seventeen hundred weight, three quarters and nine pounds, of cast iron columns, &c, at nine pounds, eleven shillings and sixpence farthing, per ton.†

* The same question may be solved by Practice, but even this will be found to be a very troublesome operation. It is scarcely possible, that a simpler question as to quantity shall occur, for the weights of iron castings must necessarily be very irregular; but fractions less than one pound are always rejected by giving and taking.

† It may be remarked, that the price of a ton of ironwork never runs so low as farthings of our present money; nor if the new money proposed were adopted, would it ever run so low as tythings. Those small denominations were chosen on purpose, to afford a more full comparison between the two systems of money under discussion.

Work in figures, by the Rule of Three.

Ton.		Tons.	Cwt.	qrs.	lbs.		£.	s.	d.
As 1	:	215	17	3	9	::	9	11	6½
20		20					20		
20		4317					191		
4		4					12		
80		17271					2298		
28		28					4		
2240 lbs.		138177					9193 Farthings.		
		34542							
		483597 lbs.							
		9193							
		1450791							
		4352373							
		483597							
		4352373							

224,0) 444570722,1 (1984690 Farthings.
224
2205
2016
1897
1792
1050
896
1547
1344
2032
2016
1621

4) 1984690 Farthings.

12) 496172½

2,0) 4134,7 8½

Answer. 2067 £. 7s. 8½d.

(256) *Secondly, by the new system of Weights and Money proposed.*

Four hundred and eighty-three thousand, five hundred and ninety-seven pounds of cast iron columns, &c, at four pounds, twenty-seven cents and five tythings per thousand weight.

Work in figures, by Multiplication of Decimals.

lbs.	£.
483,597	× 4·275
4275	
2417985	
3385179	
967194	
1934388	

Answer. 2067·377175 £.

Or 2067 pounds, 37 cents and 7 tythings.

The comparison of these two calculations for effecting the same object, will speak volumes in favor of the new system of weights and money proposed.

(257) I shall next give the statements and calculations of labourer's work, supposed to be performed in the execution of a road or canal, as measured and estimated, first by the cubic yard, and by the money now in use, that is by the present system of measures and money; and secondly by the new system of measures and money proposed, or rather by the improved system, for the units of the former are retained, their multiples and parts only being simplified.

To make this comparison complete, I must request the Reader's indulgence, if I repeat two calculations before given in Articles 72 and 73, which referred to quantity only, as money had not then been treated of. But in the business of real life, quantity and price are always combined, and for this reason it is right to give both together, in this more advanced state of our investigation.

(258) First. To calculate the cubic content of an excavation measuring 487 feet 9 inches in length, 37 feet 6 inches in mean width, and 19 feet 3 inches in depth, and to estimate the sum due to the contractor for executing the same, at thirteen pence three farthings per cubic yard.

To calculate the cubic Content.

	Ft.	In.		Ft.	In.		Ft.	In.
	487	9	×	37	6	×	19	3
	37	6						
(*a*)	27	9						
	3409							
	1461							
	18046	9						
(*b*)	243	10	6					
	18290	7	6					
	19	3						
(*c*)	11	10	6					
	164610							
	18290							
	347521	10	6					
(*d*)	4572	7	10	6				

	Yds.	Ft.	2ds.	3ds.	4ths.	
27)352094	6	4	6	(13040	14	6	4	6	the Content.
27									
82									
81									
109									
108									
14									

By rejecting fractions of a foot, and by giving and taking,

The Answer will be Yds. 13040 Ft. 15 Cube.

Extra Calculations to obtain the above.

(*a*)

Ft.	In.	
37	× 9	
9		
12)333		
27	9	

(*b*)

Ft.	In.	In.
487	9	× 6
243	10	6

6 in. = ½

(*c*)

Ft.	In.	Pts.	
19	× 7	6	
7			
12)133			
11	1		
	9	6	
11	10	6	

6 Pts. = ½

(*d*)

Ft.	In.	Pts.	In.
18290	7	6	× 3
4572	7	10	6

3 in. = ¼

To estimate the Value.

Yds.	Ft.		s.	d.	
13040	15	at	1	$1\frac{3}{4}$	per yard cube.
1					

13040s.

1d. =	$\frac{1}{12}$	1086	8
$\frac{1}{2}$d. =	$\frac{1}{2}$	543	4
$\frac{1}{4}$d. =	$\frac{1}{2}$	271	8
2,0)		1494,1	8

747£. 1s. 8d. value of the yards.

Yd.		Ft.		s.	d.
As 1	:	15	::	1	$1\frac{3}{4}$
27				12	
27				13	
				4	
				55	
				15	
				275	
				55	

27) 825 (30 Farthings.
81
15

4) 30 Farthings.

$7\frac{1}{2}$d. value of the feet.

747	1	8	value of the yards.

Answer. 747£. 2s. $3\frac{1}{2}$d. value of the whole Excavation.

(259) Secondly. To calculate the cubic content and value of the same excavation by the decimal subdivisions of the foot, and of the pound sterling, and at the price of 21 cents 2 tythings per hundred cubic feet, which is nearly equivalent to the former price.*

* It cannot be made exactly equal to it, without introducing fractions of a tything, which of course would never be used, in the pricing either of goods or of labour, if the new monetary system should be adopted. Owing to the little inequality of the two prices, arising from this cause, the former estimated value of the excavation was a little more, whilst our present estimated value will be less than 747£. sterling.

To estimate the cubic Content.

Ft.		Ft.		Ft.
487·75	×	37·5	×	19 25
37·5				
243875				
341425				
146325				
18290·625				
19½				
4572656,25				
164615625				
18290625				
352094·53125				

Or 352095 Cubic Feet, fractions being rejected.

To estimate the Value at 0·212£. *per* 100 *cubic feet.*

Ft.		£.
3520,95	×	0·212
·212		
704190		
352095		
704190		

Answer. £.746·44140

Or 746 pounds, 44 cents, 1 tything, after rejecting superfluous decimals.

This last example offers a proof no less convincing than the former, of the superiority of the proposed new system of measures weights and money, as applied to the calculations of men of business.

(260) I shall next, agreeably to the promise which I made, in treating of cloth measure, give an example of a Draper's bill, calculated first by the Rule of Three, and secondly by Practice, according to the present system of English cloth measure, and of money, as a contrast to both of which methods, I shall give thirdly, the calculation of the same bill, performed by the new subdivisions of the cloth yard before recommended in Article 29, and of the pound sterling which have just been suggested.

To find the value of 53 yards 3 quarters and 2 nails of cloth, at 2 shillings and 8½ per yard.

First, by the Rule of Three.

Yd.		Yds. Qrs. Na.				s.	d.
As 1	:	53	3	2	::	2	8½
4		4				12	
4		215				32	
4		4				4	
16 Na.		862 Na.				130 Farthings.	

130
25860
862
112060(7003 Farthings.
112
0060
48
12

Farthings.
4)7003
12)1750 3/4
2,0)14,5 10¾

Answer. 7£. 5s. 10¾

Secondly, by Practice.

53 yards 3 quarters 2 nails, at 2 shillings and 8½d. per yard.

	Yds.		s.	d.
1st.	53	at	2	8½
2s. = 1/10	£5		6	
6d. = ¼	1		6	6
2d. = ⅓			8	10
½d. = ¼			2	2½

7£. 3s. 6½d. the value of 53 yards.

	s.	d.	
2dly.	2	8½	the price of 1 yard.
½ yd. = ½	1	4¼	
¼ yd. = ½		8	
2 na. = ½		4	
	2	4¼	the value of 3 qrs. 2 nails.
Add	7	3 6½	the value of 53 yards.

Answer. 7£. 5s. 10¾d. the value of the whole.

Both of these methods are exceedingly troublesome, but there is no simpler mode of calculation practicable, with the present system of cloth measure and of money.

(261) Thirdly. To find the value of 53 yards 8½ tenths of cloth at 13 cents 5 tythings per yard, according to the new subdivisions of the cloth yard, and pound sterling proposed.

Yds.		£.
53·85	×	0·135
·135		
26925		
16155		
5385		
£.7·26975		

Hence the Answer is 7 pounds, 26 cents, 9 tythings, or more nearly 7£. 27 cents.

This very simple and easy calculation compared with either of the two former complex and laborious operations, is an additional proof of the great superiority of the new system of cloth measure and money suggested.

I shall next give the calculation of a Grocer's bill.

(262) ***First, by the present system of Weights and Money.***

19 lbs. 13½ ounces of cheese, at 11½d.

11½	
9½	
209	
12)218½d.	
18s. 2½d.	the value of 19 lbs.
11½d.	the price of 1 lb.
8 oz. = ½	5¾
4 oz. = ¼	2¾
1 oz. = ¼	¾
½ oz. = ⅛	⅜
9½d.	the value of 13½ oz.
Add 18	2½d. the value of 19 lbs.
Answer. 19s.	0d. the value of the whole.

(263) *Secondly, by the new system of Weights and of Money proposed.*

19 lbs. 8½ tenths of cheese, at 4 cents 8 tythings.
19·85 lbs.
4·8 c.

15880
7940

Answer. 95,280 cents, or 95 cents 3 tythings nearly.

(264) Thus it invariably appears that the calculations of the Tradesmen of this country, which whenever they involve compound quantities of our present measures or weights, priced in terms of our present money, are necessarily complex, tedious and confused, are greatly abbreviated and simplified, by the statement of the same quantities and prices, in terms of the new system of measures, weights and money proposed.

(265) The above being the last practical questions in common Arithmetic, that will be adduced in support of the improvements suggested in this Treatise, I beg to explain, that I believe it to be absolutely impossible to judge of one of the chief disadvantages of our present national system of measures, weights, and money, without fairly entering into such questions; and as all my readers may not be inclined to go through the investigation of those questions themselves, I judged it most expedient to insert all the calculations at full length in figures, which will enable even those readers, who may not be expert calculators themselves, to form by inspection, a tolerably correct estimate of the superior simplicity, and consequently of the great saving of trouble, that will attend the adoption of the new system of measures, weights, and money proposed. These considerations will plead my apology for having introduced matters, that might otherwise appear of too trifling a nature, to be brought forward, in the discussion of what will no doubt be acknowledged as a subject of very great public importance.

OF MEASURES OF AIR AND TEMPERATURE.

First, of the Barometer.

(266) The state of air is measured in this country, by noting the height of the common barometer, in inches, but the scale is not graduated lower than 27 or higher than 31 inches, as the mercury in that instrument usually stands somewhere

between these two extremes. No farther change will be necessary in the common barometer than to alter the scale from inches to digits, in which case, it may be graduated from 22 to 26 digits of the new measure. The portable barometer may be graduated from 12 to 28 digits.

Secondly, of the Thermometer.

(267) The thermometer most generally used in this country is that of Fahrenheit, which is graduated in such a manner that 32 degrees mark the point at which water freezes, and 212 degrees the point at which it boils. This thermometer is said also to be commonly used in Holland, and in the United States of North America. Two other thermometers, those of Reaumur and of Celsius, have been more generally used in France. Both of these thermometers are graduated from the freezing point. In Reaumur's thermometer 80 degrees mark the temperature of boiling water; but in Celsius's thermometer the space between the freezing and boiling of water is divided into 100 degrees. Consequently this has been called the centigrade or centesimal thermometer, and in consequence of its being more adapted to the decimal system, it has superseded Reaumur's thermometer in France since the Revolution, having been adopted by the French, at the same time that they established their new decimal system of measures, weights and money.

(268) On comparing these three thermometers together, the size of the divisions of Reaumur's and Celsius's thermometers appears too large, for as one degree of the former is equal to two degrees and a quarter of Fahrenheit's scale, and one degree of the latter is equal to one degree and 8 tenths of Fahrenheit's scale, they cannot express varying temperatures so well as Fahrenheit's, without making use of fractions of a degree. The great objection to Fahrenheit's thermometer is the position of the zero, at 32 degrees above the freezing point, which point appears to be much the most appropriate limit for the commencement of every scale of temperature. In fact the freezing point is the only fixed point of temperature that can be adopted: for all other criterions vary according to the state of the atmosphere, it being known that water boils at a lower or higher degree of temperature, in proportion as the barometer falls or rises, whereas the freezing point is not affected by the usual variations in the state of the atmosphere*. Another reason

* A Committee of the Royal Society, whose Report appears in the Philosophical Transactions for 1777, was appointed to consider this subject. They recommended that the boiling point should be marked on all new Thermometer tubes, at the height of 29·8 inches of the Barometer, if the

for preferring the freezing point, as the commencement of the scale, is the accurate notion which it gives of temperature. In reading Voyages or Travels in the Arctic Regions, when a very low temperature is stated in degrees of Fahrenheit, the first thing that naturally occurs, is to calculate how many degrees the stated temperature was below the freezing point. Until this has been obtained, which involves a question in arithmetical addition or subtraction, the mind can form no clear notion of the degree of cold.

For example, on reading in any of our recent memorable Arctic Voyages of Discovery, that the thermometer at any time was at 13 degrees of Fahrenheit, one has to subtract 13 from 32, and the remainder shows that the temperature was 19 degrees below the freezing point. But on reading that the thermometer was at 9 degrees below zero of Fahrenheit, one must add 9 to 32, and the sum shows that the temperature was then 41 degrees below the freezing point. In Reaumur's and in the centesimal scale, this embarrassment does not occur. If a temperature be stated at 3 degrees below zero of either of those thermometers, we know at once, that it is also exactly three degrees below the freezing point. It is likewise to be observed, in comparing those three thermometers, that the conversion of observations made by Fahrenheit's scale into either of the two others, or vice versa, is exceedingly troublesome, owing chiefly to the inconvenient position of the freezing point in the former.

(269) It therefore appears to me to be very desirable, that a thermometer should be adopted in this country, having its freezing point at zero. Fahrenheit's thermometer, modified by retaining degrees of the same magnitude as at present, and altering only the numeration of the scale, so as to effect this object, would be a very convenient instrument. In this case, the freezing point being marked at zero, as has been stated, the boiling point would be marked as 180° instead of 212°, and every tenth degree above and below zero would be marked accordingly. But as this arrangement would involve the adoption of what may be considered

bulb and tube be exposed to the steam of boiling water in a close vessel, with the bulb an inch or two above the surface of the water: but that the same point should be marked at the height of 29·5 inches of the Barometer, if the bulb and lower part of the tube only be immersed in boiling water. This suggestion was made to prevent, for the future, such differences in the position of the boiling point, as had been observed in thermometers made by the best artists of that day, amounting to 2° or 3°. They also gave rules for correcting the position of the observed boiling point of new thermometer tubes, at other heights of the barometer, lower or higher than the above, in order to reduce the graduation of the scale of every new thermometer, to the same standard proposed by them, and to mark it accordingly.

an entirely new thermometer, not before used in this or in any other country, it may probably be deemed preferable to adopt one of the two other thermometers, which have been mentioned. In coming to this decision, we would most probably reject Reaumur's scale, from the circumstance of its having become obsolete, even in that country where it was the most generally used.

(270) Upon the whole therefore, it may perhaps be allowed to be most convenient, to adopt the centesimal thermometer, the principle of the graduation of which is very simple, which may have its degrees halved for common purposes, or subdivided decimally for more delicate purposes; and which possesses the great advantage of being very extensively used in France and other countries, by men of science, whose observations we must necessarily study in this country also.

Under these considerations, I before proposed in Articles 125 and 217, that the value of the new pound weight, as deduced in proportion to the weight of the new cubic foot of distilled water, at a certain temperature, &c, should be determined in reference to the centesimal thermometer.

(271) The improved system of measures and weights suggested in the foregoing pages, having now been fully explained, it still remains to consider the means which ought to be adopted for fixing the new standards, in the event of this system being approved. But before we enter into these details, it may be acceptable to my readers, to take a brief survey of the improvements, which have been introduced, chiefly within the last century, in the delicate operations upon which the accuracy of all standards of measure or of weight depends, and of which in former ages, the theory was not understood, and even the obvious practical part too much neglected.

OF THE INACCURACY OF THE OLD ENGLISH STANDARDS OF MEASURES, &c. CIRCUMSTANCES WHICH LED TO THEIR IMPROVEMENT. PROCEEDINGS OF THE ROYAL SOCIETY CONNECTED WITH THIS OBJECT.

(272) From the earliest periods of English History, considerable anxiety has been shown, to establish a proper uniformity of measures and of weights. Those standards of each sort, which were approved for the time being, were preserved in the King's Exchequer, from whence authenticated copies were supplied to the several Burghs and County Towns; and all deviations from these standards

were prohibited, under severe penalties, by successive laws, which form a considerable portion of the contents of the Statute Books of England. These laws never produced the desired effect: nor does it even appear that the standards which they were intended to establish, were used in any part of England, excepting in and near the Metropolis, as being the seat of Government; and excepting also in the collection of the Duties of the Customs or Excise, in which the use of the legal standards was inforced by the Revenue Officers, who depended immediately upon the Government; but no sooner had the Merchants or other dealers paid those duties upon such goods as were liable to them, than they set aside those standards, and sold the same goods to the public, by the several customary or local measures and weights in use, in their respective places of abode, or in the markets which they frequented. The inconvenience of the many discordant measures and weights, thus prevailing in various parts of England, was however always strongly felt, and many zealous attempts at improvement were made from time to time, in the successive reigns of the Kings of England, not only after but even before the Norman Conquest. That all those efforts failed, was owing to a combination of circumstances, which in an imperfect state of civilization, of internal commerce, and of knowledge, it seems absolutely beyond the power of Kings and Parliaments to control. If even the more recent law for introducing the standard measures and weights of England into Scotland, since the period of the Union, was totally disregarded, as has been before stated in Articles 214 and 215; how much less likely were the more ancient laws on the same subject to have been attended to, in either country, during the violence, confusion and ignorance of the feudal ages. No wonder, therefore, that considerable changes, which I have already adverted to, took place even in most of the legal standards of measures of capacity and of weight, as regulated by the Officers of the Royal Exchequer in London, independent of the prodigious number of discordant local measures of capacity and weight, which set those standards altogether at defiance. I have already noticed not only the changes alluded to, but the very imperfect and incongruous nature of the standards preserved in the Exchequer, and in other official places, which were so carelessly made, that no two standard measures or weights of the same description were equal; and no two standards of the same kind of measure or of weight, but of unequal magnitude, were the exact multiples or aliquot parts of each other, that they ought to have been.

(273) In respect to lineal measure, which as I said before, had not undergone any material change since the Norman Conquest, and certainly no intentional one, the standards preserved in the Exchequer, which were of the reign of King Henry the Seventh and Queen Elizabeth, as well as the copies thereof issued from the same office to Guildhall, and to the Clockmakers' Company, in the next century, were of the rudest description, and yet these were the only legal standards extant, until a few years ago. These standards consisted partly of brass yard rods, or brass ell rods about half an inch in thickness, square or octagonal; and partly of brass standard yard-and-ell beds, consisting of substantial bars of brass, rather more than four feet long, and each having a hollow bed or matrix on one side for receiving the standard yard measure, and another on the other side for receiving the standard ell measure, in the manner shown in the annexed figure.

Standard Yard Bed.

Standard Ell Bed.

When a new yard or ell measure was brought to the Exchequer, or to Guildhall to be examined, it was applied to the hollow bed, on the proper side of the above rod, and if it fitted tolerably well, it was approved, and authenticated by the seal or stamp of those offices. These standard rods and beds were generally crooked. Neither the ends of the rods, nor the projecting parts of the standard beds, were at right angles, as they ought to have been, and the divisions into feet and inches on the standard yard rod of King Henry the Seventh, were irregular and oblique, and marked by lines, so extremely thick, that this last circumstance alone, without any other defect, would have put accuracy out of the question. None of the standard yard rods, or yard beds agreed with each other; the difference between the longest and shortest of these yards being rather less than one-tenth of an inch, or 360th part of the whole length, whilst the difference between the shortest yard and longest yard bed, was a little more than one-tenth of an inch.

(274) These incongruities in standards, from which the law prohibited all deviation by the severest penalties, and the system of determining the length of a standard measure by a bed, which is in itself a very inaccurate process, may excite a smile in the present day, but I am not willing to ascribe them either to want of natural talent on the part of

the responsible persons, for talent has never been wanting in any age, nor even to the want of manual dexterity in the workmen of the sixteenth and seventeenth centuries. On the contrary, it appears to me, that the experience of ages has sufficiently proved, that accuracy even in the official legal standards of measures and of weights cannot reasonably be expected in any country, until science shall be so extensively cultivated, that not only men of high acquirements, but the public generally, shall fully appreciate the value of the most perfect time pieces and correct mathematical instruments, which the art of man is capable of producing at the time being. Accordingly nothing effectual towards this important object was done in England, nor in any other part of Europe, until after the beginning of the last century, when the sublime discoveries of Sir Isaac Newton and other eminent men in Astronomy, Optics, and the higher branches of Mathematics, had been generally appreciated; and more especially after the difference of opinion between Sir Isaac and Huygens on one side, and the first celebrated Cassini and his son on the other, as to the figure of the Earth, had led to the measurement of a large arc of the meridian, comprehending the whole extent of France from Dunkirk to the Pyrenees, and to two still more interesting measurements, also made at the expense of the government of France, who sent out one mission for that purpose to the equator in 1735, and another to the arctic regions in 1736. These surveys, which excited great interest throughout the whole civilized world, and which were all completed about the middle of the eighteenth century, caused a degree of importance to be attached to extreme accuracy in the surveying instruments, and standard scales of lineal measure used, which had never before been deemed necessary for the purposes of surveying; and led to great improvements in the construction and graduation of astronomical and mathematical instruments, and scales, in which our British artists were highly distinguished. For it is not to be denied, that those first attempts at ascertaining the figure of the earth by actual surveys, although equally creditable to the government of France, to the Royal Academy of Sciences at Paris, by whom they were suggested, and to the distinguished Frenchmen, by whom they were executed, all members of that scientific body, were made with instruments much inferior to those which came into use towards the end of the same century, such as Ramsden's Theodolites in England, and Borda's repeating circles in France.

(275) It may be remarked, that all other standards of measure, and all standards of weight in every country must either be deduced from, or fixed in reference to, the standard of lineal measure. In England, France, and most other countries of Europe, this important standard was a multiple of the respective foot measure of each, which were all originally deduced from the ancient Roman foot, and in the time of Charlemagne were probably equal or nearly so, but which in the course of twenty centuries had all been altered more or less, and become unequal in consequence.* In England the Yard, and in Spain the *Vara*, each of 3 feet, were the standards of lineal measure. In France the Toise or fathom of 6 feet was the standard, and even after the middle of the last century, this standard was still more carelessly made and preserved than in England, for the only legal standard in Paris was an iron toise bed, chained to the staircase of the Grand Chatelet where the Law Courts of Paris were held, and which was there exposed not only to oxidation from the atmostphere, but to injury from idle or mischievous persons.†

* The present English foot may be considered the mean foot of Europe; very few countries having a foot of less than 11 or more than 13 English inches, except in Italy, where the more general use of the Palm has led to a greater enlargement or corruption of the ancient Roman Foot, which has been estimated at about 11 inches and 6 tenths of our present English measure.

† Extracts from Paueton's Metrologie ou Traité des Mesures, Poids et Monnoies, published at Paris in 1780.

" Les étalons actuels des poids et mesures de Paris ne sont pas tous en " depôt au même endroit, ni confiés à la garde des mêmes personnes. La " Toise qui est l'étalon des mesures linéaires ou longitudinaires, est con- " servée en fer, et au grand Châtelet de Paris, et dans le Cabinet de l'Aca- " démie des Sciences au vieux Louvre."

" Ce nouvel étalon de la toise est une barre de fer scellée dans le mur " au pied de l'escalier du grand Châtelet, terminée par deux saillies ou " redans en retour d'équerre. Il est grossiérement construit, ses angles " sont emoussés, les faces intérieures des deux redans, qui doivent com- " prendre la toise qu'on y presente, n'ont jamais été polies, ni limeés d'e- " querre et parallelement l'une a l'autre ; il est d'ailleurs exposé au chocs, " aux injures de l'air, a la rouille, au contact de toutes les mesures, qui y " sont presentées, et a la malignité même de tout mal intentionné."

This last was the only legal standard toise measure in France. It is called new (nouvel) by Pauceton, because it is said to have been altered in 1668, by making it half the width of a gate of the Louvre, which was estimated as being 12 French feet wide, instead of a former standard toise, whose length exceeded half the width of the said gate by 5 lines or twelfth parts of an inch of French measure. Pauceton says that nobody knows by whom, or why, or under what circumstances, this alteration was made, which in his time was only known by a kind of tradition. The standard toise of the Royal Academy of Sciences of Paris, was the same that had been used in Peru, in the survey of part of the terrestrial meridian under the equator before alluded to. This although not originally a legal standard superseded the other, and was considered the only accurate standard French Toise, until it was itself superseded by the Metre, when the new decimal system of measures and of weights was adopted in France.

(276) Such was the state of things, when the Royal Society of London invited the Royal Academy of Sciences of Paris, to make an exchange of the legal standards of measure and of weight of their respective countries. This offer having been accepted, the Royal Society employed Mr. Graham an eminent chronometer maker and a distinguished Fellow of their own body, to prepare their standards, which he did by causing two sets of Troy weights and of Avoirdupois weights to be made by Mr. Samuel Read, according to the mean weights of those preserved in the Exchequer, Mint, &c. in which great care was taken to avoid the incongruities of those official standards. His brass yard measures, for which the rods were prepared by Mr. Sisson, but which he divided himself, were copies of a standard brass scale of excellent workmanship, made by Mr. Rowley about 20 years before by order of the Board of Ordnance, for the use of their draftsmen in the Tower of London, the length of the yard of 36 inches marked upon which was a mean between the discordant standards at the Exchequer, and which had been stamped with the Exchequer seal, as having been authenticated there.* Two brass standard rods, having been marked by Mr. Graham with three feet, according to the above Tower standard, were sent to the Royal Academy of Sciences at Paris, where the half toise of three French feet having also been carefully marked upon each, one of them was sent back and preserved in the archives of the Royal Society, whilst the other was kept at Paris. Of the Troy and Avoirdupois weights, one set was in like manner preserved in the archives of the Royal Society, whilst the duplicates were sent to the Royal Academy of Sciences in Paris, from whence the Society received in return a French standard pound weight *(the Livre de Marc)*, the only legal pound then acknowledged in France. It is to be observed, that the length of the standard French half toise was not deduced from the rude iron standard kept at the Grand Chatelet of Paris, but from an iron toise of superior workmanship, kept at the Academy of Sciences, which from having previously been used in the measurements of the arc of the meridian under the equator, was known either by the name of the Academy Toise, or Toise of Peru. This interchange of the lineal

* The Drawing Room in the Tower of London was originally the place of instruction not only of the draftsmen under the Ordnance, who were more recently made a military corps, called Royal Military Surveyors and Draftsmen, subsequently discontinued, but also of their Engineer Officers, before the Royal Military Academy at Woolwich was instituted, for the education of officers of the Ordnance Military Corps.

measures and weights of France and England took place in the year 1742.

(277) In the following year, it having been doubted whether the standard weights and yard, thus prepared by Mr. Graham, were identical with the legal standards preserved in the Exchequer, and it having been objected, that his standard yard in particular was only the copy of a copy, as the brass scale at the Tower, in spite of its superior workmanship had no legal authority, like the standards in the Exchequer, a committee of the Royal Society, of which Mr. Graham himself was a member was appointed to examine all those standards, and their report appears in the Philosophical Transactions for 1743. I believe that this inquiry, which was conducted with a degree of minute accuracy, unparalleled before, first brought into public notice the extreme inaccuracy and incongruities of all the standard measures and weights preserved at the Exchequer, Guildhall, the Mint, and in charge of the Clockmakers' Company, Founders' Company, &c. Consequently the Royal Society could not do less than approve of the standards prepared for their own use by Mr. Graham, as being the mean of the official standards of the like description, but with the advantage of being free from all their perplexing incongruities. These proceedings of the Royal Society of London, and of the Royal Academy of Sciences of Paris, first led to the determination of the measures and weights of their respective countries with proper accuracy; and from that period, the use of measures of inferior workmanship or of unequal divisions, or even perceptibly deviating from the standard yard of the Royal Society, although not established by law, or the use of incongruous weights in any operation of importance, would have been considered disgraceful even to a private individual in this country.

PROCEEDINGS AND REPORTS OF A COMMITTEE OF THE HOUSE OF COMMONS ON WEIGHTS AND MEASURES, IN 1758 AND 1759.

(278) After an interval of about sixteen years, the attention of Parliament was drawn to this important subject, when a Committee of the House of Commons was appointed "to inquire into the original standards of "weights and measures in the United Kingdom, and to "consider the laws relating thereto, and to report their "observations thereupon, together with their opinion of "the most effectual means for ascertaining and inforcing

"uniform and certain standards of weights and measures "to be used for the future." The two Reports of this Committee, drawn up by Lord Carysfort their chairman, and printed in 1758 and 1759, contain a valuable mass of information, both as to the history of our national weights and measures, and the state of all the existing standards preserved at the Exchequer, Mint, and other official places, which they caused to be examined with the greatest care. In this examination, the results of which are stated in their Reports, they included not only the official standards of lineal measure, and of weights, which had previously been examined by the Committee of the Royal Society, but also the standards of the measures of capacity, preserved at the Exchequer, Guildhall, &c. in which they found still greater incongruities than in the former. They directed Mr. Bird an eminent artist, to make two standard yard rods, in conformity with the Royal Society standard, which they approved: and at the same time they authorized Mr. Harris then assay master of the Mint, who had conducted the practical part of many of their examinations of existing standards, with great skill and care, to prepare a set of Troy weights, consisting of one Pound Troy and several of its binary multiples as well as of its usual aliquot parts, which he did with extreme accuracy. In determining the value of this Pound, he adopted the Troy pound used for weighing gold at the Mint, in preference to the Troy pound of Queen Elizabeth at the Exchequer, which was about a grain and a half lighter, under a supposition that the latter might have lost weight by being constantly used in the verification of new weights for about 170 years.*

(279) Nothing further was done till the year 1765, when Lord Carysfort brought in two bills, embodying the resolutions of the above Committee, one for establishing uniform and certain standards of weights and measures, &c, and another for inforcing the use of those standards, which were to be carried into effect from and after the 24th day of June in the year 1769; but from some cause, of which I have not been able to trace any record, these bills after having each been read twice in the House of Commons were never brought under the consideration of the House of Lords, and therefore the subject of weights and measures again lay dormant for many years. The standard brass yard rods, and the standard Troy weights, that had

* Whilst they adopted the Royal Society standard yard, it is remarkable, that they took no notice whatever of the standard weights of that Society, which had been prepared with no less skill and care.

been prepared by order of the Committee of 1758 and 1759 were however carefully preserved in charge of the Clerk of the House of Commons, and were afterwards adopted as the legal imperial standards of Great Britain; and the principle then suggested, that there, ought to be only one legal gallon instead of three, was also acted upon, in the recent establishment of the imperial measures of capacity. In one respect it may be considered fortunate, that the resolutions of the Committee of 1758 and 1759 were not carried into effect at the time, for admitting the soundness and expediency of their proposition, that there should only be one weight instead of two; one cannot agree with them in opinion, that the Pound of Troy weight used only for a few special purposes, should have had the preference over the Pound Avoirdupois, which is used for the general purposes of commerce by all classes of the community, in the every day business of life.

OBSERVATIONS AND EXPERIMENTS OF SIR GEORGE SHUCKBURGH EVELYN, WITH A VIEW TO FIX INVARIABLE STANDARDS OF MEASURES AND OF WEIGHT.

(280) The subject of measures and weights was afterwards taken up by Sir George Shuckburgh Evelyn, Bart. Fellow of the Royal Society, who had before distinguished himself by his researches into the Barometrical measurement of the heights of mountains. The following is a brief outline of his proceedings, which are described at full length in the Philosophical Transactions of the Royal Society for the year 1798. Having provided himself with a brass standard measure, and a set of Troy weights, as well as with a microscope and micrometer apparatus, a hydrostatic balance, &c, all of excellent workmanship, made by the celebrated Troughton, and which far surpassed in minute accuracy, any that had been used before in the like operations, Sir George Shuckburgh remeasured, and compared with his own standard, all the standard yard and ell measures which had been examined before in 1758, by the Committee of the House of Commons, and he also included in this examination several brass standards or scales made by Sisson and Bird for private individuals, one of which made by the latter, had been used by General Roy in commencing the Trigonometrical Survey of England and Wales. In all these comparative measurements, Sir George Shuckburgh paid the greatest attention to a precaution not altogether unknown to the Parliamentary Committee of 1758 and 1759, but which had not been systematically acted upon by them in

their operations. This consisted in examining the thermometer at every step of his comparative measurements, in order to guard against the errors, which must necessarily result from the comparison of different scales at unequal temperatures:* and he carried his comparative measurements to such an extreme of minuteness, that he even examined the accuracy of the several divisions upon the divided scales, stating the errors of each.

Having also provided himself with a solid cube and cylinder of brass, the former with sides of 5 inches, and the latter being 4 inches in diameter and 6 inches high, together with a solid and with a hollow sphere of the same metal, each 6 inches in diameter, after repeatedly weighing the whole of these in air and in distilled water, and carefully noting the state of air and temperature at each process, Sir George Shuckburgh found the weight of one cubic inch of distilled water to be 252 Troy grains, and 422 thousandth parts of a grain of the Parliamentary standard Troy weight of 1758. This part of his operations was particularly important, as it formed the connecting link between Troy weight and lineal measure, in such a manner, that if one of these standards were lost, it might be recovered from the other, which had not been attempted before in England, at least not to any great degree of accuracy.

(281) Sir George Shuckburgh had it also in view, to fix the standard of lineal measure in reference to the pendulum, which had not been attempted by the Committee of 1758, but which in the intervening period, had become a favorite subject of speculation both in England and in France, and had even been carried to considerable perfection in the latter country, some years before by Cassini and Borda. Sir George's proceedings in this investigation are not of much importance. After a few experiments he desisted from the attempt, and merely recommended the method that had previously been suggested by Mr. Whitehurst, also a Fellow of the Royal Society, which although very ingenious, was afterwards superseded by more simple methods.

PROCEEDINGS OF THE HIGHLAND SOCIETY OF SCOTLAND IN 1811, AND 1812, AND OF THE SELECT COMMITTEE OF THE HOUSE OF COMMONS ON WEIGHTS AND MEASURES IN 1814.

(282) The subject appears to have been rather ne-

* The practice was not however altogether new, having been used before, with the greatest care, by General Roy in England, and by the Count Cassini and Borda in France.

glected from that time, until it was taken up by the Highland Society of Scotland, at their anniversary General Meeting in January 1811, when at the request of several Members a Committee was appointed, to consider how far and in what manner, the Society could contribute to the establishment of a general uniformity of weights and measures all over Scotland. I forbear to enlarge upon the Reports of this Committee, the members of which, after taking great pains to acquire information upon the subject, abstained from suggesting any thing new, but merely recommended the strict inforcement for the future, of that clause of the Act of Union, which had directed that the standard weights and measures of England should supersede those of Scotland, but which had hitherto been entirely disregarded, as was before mentioned. These proceedings must, however, undoubtedly have given a salutary impulse to the consideration of this important subject, for in less than two years after the Committee of the Highland Society made their final Report, a Select Committee of the House of Commons, of which Sir George Clerk Bart. was President, was appointed to enquire into and report upon the whole system of weights and measures of the United Kingdom, and in their inquiries, which were to be of the most comprehensive nature, they were directed to ascertain, first what were the original standards, secondly to consider the standards suggested by the former Committees of 1758 and 1759, and finally to state their own opinion of such improvements as ought to be adopted for the future.

PROCEEDINGS OF THE ROYAL COMMISSIONERS, APPOINTED IN 1818, WHOSE REPORTS LED TO THE IMPERIAL STANDARDS ETABLISHED BY LAW IN 1824 AND 1825.

(283) The suggestions of the above Select Committee of the House of Commons, as contained in their Report, which was ordered to be printed on the 1st of July 1814, not having been approved by the House of Lords, the same subject was referred to a Committee of the Royal Society in 1816, and afterwards to Commissioners appointed by His Royal Highness the Prince Regent in 1818, as was before mentioned in Article 1, consisting of the then President and some of the most distinguished Fellows of the same Society, two of whom being Members of Parliament, had previously been employed upon the Select Committee of the House of Commons. Of those Royal Commissioners, the most distinguished and useful in all the practical opera-

tions was Captain Kater, to whom his colleagues chiefly confided the important and arduous task of the remeasurement of former standards, and eventually of the preparation of new ones.*

(284) The Commissioners made their several Reports upon the subject of weights and measures in the years 1819, 1820, and 1821, and their last Report having been approved by a Select Committee of the House of Commons in the same year, the opinions and suggestions of those Commissioners were finally sanctioned by the Legislature, and made the basis of the system of imperial weights and measures, soon afterwards established by law.

In their final Report of 1821, the Commissioners, as might naturally be expected, saw reason to correct or modify some little details in their former Reports, which they subsequently considered to be inaccurate, or capable of improvement. I shall therefore merely state the general and final result of their proceedings, as confirmed by the Legislature in 1824 and 1825.

First. It was declared that the distance between the centers of the two points in the gold studs in the straight brass rod, made by Bird, by order of a Committee of a former House of Commons, and marked "Standard Yard, 1760," should be the only legal standard of lineal measure, to be used as such at the temperature of 62 degrees by Fahrenheit's thermometer, and that all other measures of length and surface should be derived from it.

Secondly. That the brass weight made by Harris, by order of the same Committee of the House of Commons in 1758, of one pound of Troy weight, should be the only standard of weight from which all others should be derived, and that the pound of avoirdupois weight should contain 7000 grains, of which the above Troy pound contained 5760.†

* Sir Joseph Banks President of the Royal Society was also President of this Commission. The other Commissioners were Sir George Clerk, Bart. M.P., Davies Gilbert, Esq. M.P., Dr. W. Hyde Wollaston, Dr. Thos. Young, and Captain Henry Kater. Sir Joseph Banks died after the first Report was made. Mr. Davies Gilbert had been particularly zealous, as he had previously moved a Petition in the House of Commons to the Prince Regent, which led to further Proceedings, after the Select Committee of the House of Commons of 1814, had failed in the object, which they had in view.

† The proportion between Troy weight and Avoirdupois weight had never before been fixed by law, and was estimated differently by different persons. The proportion of 7000 grains Troy to the pound Avoirdupois was the best, that could have been adopted. The Committee of the House of Commons of 1759 had declared, that the pound Avoirdupois was equal to 7008 grains Troy, a much more inconvenient proportion than the former, even if more accurate, which may be doubted, for as I have so often mentioned, no two of the legal standards of measure or of weight then extant, exactly agreed with each other. In the Bill prepared by Lord Carysfort in 1765, the proportion had been altered from 7008 to 7002 grains.

Thirdly. Being of opinion that the simplest practical mode of determining the proper contents of measures of capacity is by the weight of distilled water, whilst they adopted the principle of the Committee of the House of Commons of 1758 and 1759, that there should be only one gallon instead of three, the Royal Commissioners recommended, that this new gallon should contain exactly ten pounds avoirdupois weight of distilled water. This arrangement, in combination with the ascertained specific gravity of that fluid, led to the establishment by law of the imperial gallon of 277 cubic inches and 274 thousandth parts of a cubic inch.

Fourthly. It was declared that the imperial standard yard rod of lineal measure, when compared with a pendulum vibrating seconds in the latitude of London in a vacuum, at the level of the sea, was in the proportion of 86 inches to 39 inches and 1393 ten-thousandth parts of an inch; and farther that a cubic inch of distilled water, weighed in air by brass weights, at the temperature of 62 degrees of Fahrenheit's thermometer, and with the barometer at 30 inches, was equal to 252 Troy grains, and 458 thousandth parts of a Troy grain.

(285) These two proportions, both fixed by Captain Kater, after a series of the most laborious and accurate experiments, were inserted as a part of the Statute, by which the imperial measures and weights were established, for the express purpose of affording the means of restoring the said standards of measures and of weight, if hereafter lost, destroyed or injured; the former in reference to the length of the seconds' pendulum, an invariable measure of nature, and the latter in reference to the proportion between cubic measure and weight of distilled water before-mentioned, which differed a little from that previously stated by Sir George Shuckburgh in 1798.

(286) In respect to the multiples and aliquot parts of the standard yard, namely the mile, furlong, rod, foot, inch, &c, and in the system of land measure derived from it, consisting of acres, roods, perches, &c, they made no change whatever; and they also confirmed the usual multiples and parts both of the Troy pound, and of the Avoirdupois pound; and in like manner, they confirmed all the old multiples and parts of the gallon, without making any further change, than what necessarily resulted from the establishment of one gallon instead of three, by which our wine measure and corn measure were increased, but our ale measure a little diminished.

(287) It may be remarked, that this establishment of a new gallon, which is the only absolute change, is also the only simplification of the existing measures and weights of England, recommended by the Royal Commissioners in 1821, and adopted by the Legislature in 1824 and 1825. Hence although standards of excellent workmanship, and free from all incongruity, were substituted for the rude standards of the sixteenth century; yet with the solitary exception which has just been noticed, the legal weights and measures of this country, considered as a system, were still allowed to remain encumbered with all the complex details, animadverted upon in the preceding parts of this Treatise, which although partly borrowed from the ancient Romans, grew to their present form in the dark ages, and which have opposed the same obstruction to the internal commerce of this country, that the old Bridges of London and Rochester, no less venerable from their antiquity, opposed to the navigation of the Thames and Medway.

REMARKABLE IMPROVEMENTS, IN THE MODE OF COMPARING AND ASCERTAINING THE ACCURACY OF STANDARDS OF LINEAL MEASURE, FIRST ADOPTED BY SIR GEORGE SHUCKBURGH.

(288) Before the Royal Commissioners finally decided upon recommending the Parliamentary standard yard rod made by Bird in 1760, to be adopted as the imperial standard of lineal measure, Captain Kater had by their authority examined various British standards, with a view to the selection of that which might appear the most suitable. Abstaining from the re-examination of the discordant standard yards, and ells, and yard and ell beds of the sixteenth century, which had been sufficiently reported upon by Sir George Shuckburgh, and which were evidently unfit for accurate standards, he confined himself to the comparison of the Royal Society standard yard rod of 1742, with four other standard brass scales of subsequent date, which had all been copied from that as their common model, and which, with one exception only, had also previously been examined by Sir George Shuckburgh. No modern scale, excepting those whose makers were artists of the highest reputation, and which had been prepared either for their own use, or for men of science were noticed. Indeed in the examinations alluded to, the pedigree of a scale was sometimes traced with as much care, as that of the gifts of

Homer's heroes.* Now from what has been stated, it might reasonably be supposed, that the whole of the brass scales alluded to, having been copied from the Royal Society standard, in like manner as that itself was a copy of the Ordnance standard scale of 1720, should have been exactly equal to those two standards and to each other: and indeed they do agree sufficiently for all the practical purposes of common life, such as laying out the foundations or raising the walls of the largest building, in which scarcely any perceptible difference would occur, between the tracing of the necessary dimensions by the longest or by the shortest of all those scales.

(289) The coincidence intended by their makers was not however found to have been attained, when they were examined and compared together, first by Sir George Shuckburgh and afterwards by Captain Kater, who ascertained that there was a certain difference, even between those made by the same artist, at or about the same time. Hence of the two Parliamentary standards made by Bird in 1758 and 1760 the Royal Commissioners gave the preference to the latter, chiefly on account of its being nearly equal to Sir George Shuckburgh's standard brass scale, the workmanship of Troughton, which appears to have been the most accurate in its divisions of any that had hitherto been produced, and to another similar brass scale, probably of equal accuracy, made by the same eminent artist, and used by Professor Pictet of Geneva in his comparisons of French and English measures, and which on his authority had been accepted on the continent of Europe as the genuine standard of English measure.

(290) It was their intention at first, to have recommended a brass scale known to have been made by Bird and used by General Roy in the Trigonometrical survey of England, to be adopted as the legal standard of lineal measure, but Captain Kater afterwards discovered, in the course of his examination of the various standards now

* For example, Sir George Shuckburgh's description of one of the scales examined by him is as follows.

"The first of the above mentioned scales belonged to the late General "Roy, and was purchased by him at Mr. Short's sale, the celebrated opti- "cian: it was used by him in his operation of measuring a base line on "Hounslow Heath (See Phil. Trans. vol. LXXV). It was originally the "property of Mr. G. Graham, has the name of Jonathan Sisson engraved "upon it, but is known to have been divided by Mr. Bird, who then worked "with old Mr. Sisson. It is 42 inches long, divided into tenths, with a "vernies of 100 at one end, and of 50 at the other, giving the subdivisions of "500ths, and 1000ths of an inch."

The history of this scale will bear a comparison with that of Agamennon's Sceptre, in the second book of Homer's Iliad.

alluded to, that this scale and an iron standard bar used by Ramsden, who made all the other measuring instruments for this survey, did not agree; and it is not surprising that they should differ, since they were the workmanship of different artists. In consequence of this very unexpected discovery, as they term it in their second report, "of an "error having been committed in the construction of some "of those instruments," the Commsssioners gave the preference to Bird's parliamentary standard of 1760.

(291) That neither General Roy's brass scale nor Ramsden's iron standard bar, nor indeed any of the other standards examined by Sir George Shuckburgh or by Captain Kater were exactly equal, is not to be ascribed to want of talent or care on the part of the makers, but in some cases, to the want of the more perfect instruments afterwards contrived, and probably in others to the omission of the laborious precautions to insure accuracy, afterwards adopted by Sir George Shuckburgh and Captain Kater, of which the absolute necessity was not generally understood, although the principle was known before the former commenced his proceedings. It must also partly be ascribed to the difficulty of the operation itself, for even with the improved apparatus and experience of the present day, I am informed that the most intelligent artists can scarcely hope to arrive nearer to absolute equality, in the construction of successive scales of the same metal, than the five thousandth part of an inch.* Of those examined by Captain Kater, the difference between one yard on Lieut.-Colonel Lambton's scale made by Cary, which was the shortest, and on Ramsden's bar, which was the longest of the whole, only amounted to the 318th part of an inch, which difference no human eye can distinguish, and no human hand can measure, without the aid of the microscope and micrometer.†

* I believe that the most accurate and useful instrument for the division of plane scales, is that which has been contrived on the principle of the micrometer, by Mr. Bryan Donkin, civil engineer of Bermondsey.

† From Captain Kater's account of the comparison of various British standards, published in the Philosophical Transactions for 1821, No. VII, it appears, that the scale used by Colonel Lambton in the survey of India falls short of Bird's standard yard of 1760, now the legal imperial yard, by 659 millionth parts of an inch, that Sir George Shuckburgh's standard falls short of it by 17 millionth parts of an inch, that General Roy's brass scale made by Bird himself exceeded it by 1537 millionth parts of an inch, that the Royal Society's standard exceeded it by 2007 millionth parts of an inch, and that Ramsden's bar used in the trigonometrical survey of Great Britain exceeded it by 2488 millionth parts of an inch. Bird's standard yard rod of 1760, and Ramsden's bar of 1794, were both professedly copied from the Royal Society standard of 1742, and as the former falls short of the Royal Society standard by 1348 millionth parts of an inch, and the latter exceeds

(292) The chief superiority of the measurements of Sir George Shuckburgh and Captain Kater over their predecessors in the same sort of practical inquiry, consisted in abandoning the beam compasses, in using which, after the two pointed legs had been applied and adjusted to the extreme points of one standard, the compasses were removed and applied to the second standard or scale, placing one leg accurately upon one of the two corresponding points of this scale, with the other leg upon or nearly upon the second corresponding point. If the two standards agreed, the second leg of the beam compasses would also coincide with the second point of the new scale. If not, this leg was moved by means of a micrometer screw, until it exactly coincided with the said point; and the distance indicated by the divisions of the micrometer during the movements of the screw, which were necessary for effecting this coincidence, showed the difference by which the second scale exceeded or fell short of the first. This process, of fixing and moving the pointed legs of the beam compasses, was not only liable to injure the fine points or lines of the original standard scale, as well as of those compared with it, but was also less accurate than the system of microscopic micrometers, first applied to this peculiar purpose, by Sir George Shuckburgh, in which not only such injurious friction, but even contact were avoided. In this ingenious yet simple apparatus, instead of pointed legs, two delicate microscopes were used, projecting equally beyond one side of a beam of brass, or of seasoned wood, along which they were movable and to which they could be firmly clamped, in any required position. This beam with its microscopes being fixed down upon a table, the standard, with which other scales were to be compared, was placed alongside of it, and the microscopes were adjusted so that the centre of each stood exactly over the extreme points of the standard, and in this position they were clamped down to the beam. The standard scale was then removed, and the scale which was to be compared with it was placed in the same position alongside of the beam, with its zero point exactly under the center of one of the two microscopes. In this position, supposing the distance under examination was a yard, if the one-yard

it by only 1140 millionth parts of an inch, the latter although rejected by the Commissioners is in reality a more accurate approximation to its prototype, than the former. In stating this fact deduced from Captain Kater's own report, I have no wish to criticise the decision of those Commissioners, whose reasons for preferring Bird's standard of 1760 have been stated, and were approved by the legislature.

point, or 36 inch point of the new scale, was also exactly under the center of the second microscope, it proved that this scale was equal to the former, provided that they were both at the same temperature. If this coincidence did not take place, a fine wire within the second microscope was moved away from the center, until it covered the above point, by means of the micrometer screw, the divisions of which indicated the space measured by this movement, or the difference of length of the two scales, to the ten-thousandth part of an inch in Sir George Shuckburgh's experiments, but in Capt. Kater's to less than the twenty-thousandth part of an inch:* and these gentlemen always took the mean of a great number of observations, instead of trusting to a few. What a contrast between the extreme care with which our last standards of lineal measure have thus been compared, and the great negligence, that must have prevailed in the examination of the slovenly standard yard and ell rods, and yard and ell beds of Henry the Seventh and Elizabeth.†

(293) I had written thus far, without having seen the various standards alluded to, in the preceding observations, in which I was therefore necessarily guided by the authority of the eminent men, whose successive reports upon them have been published, in the Transactions of the Royal Society, or by order of the House of Commons. Having since inspected all the old English standards in the Exchequer, as well as those at the House of Commons, whilst I found that the inaccuracies of the former had been fully and faithfully recorded; I was surprised that no notice had

* In Sir George Shuckburgh's microscopic micrometer, the circular head of the screw by which the micrometer was moved, had a scale of 100 equal parts marked upon it, and ten revolutions of the screw effected a movement of one-tenth of an inch. Hence each division of this scale indicated the ten-thousandth part of an inch. Captain Kater's micrometer screw made more than twenty revolutions in moving the tenth of an inch.

† Sir George Shuckburgh reports, that Henry the Seventh's standard yard of 1490 measured 35·924 inches, that the standard yard of the Clockmaker's company of 1671 measured 35·972 inches, that the yard deduced from the standard ell-bed of Guildhall of about 1660 measured 36·014 inches, that the standard yard of Queen Elizabeth of 1588 measured 36·015 inches, that the yard deduced from the standard ell of the same reign and date measured 36·016 inches, and that the standard yard-bed of Guildhall of about 1660 measured 36·032 inches of his own scale, which was made for him by Troughton. He even found a difference of the tenth of an inch, between the second and third of the three feet, marked on King Henry the Seventh's standard yard, the third division being the longest. In respect to the standard yard and ell of Queen Elizabeth, he observes, that "they are very "rudely divided indeed, into halves, quarters, eighths and sixteenths; the "lines being two or three hundredths of an inch broad, and not all of them "drawn square or at right angles to the sides of the bar, so that no accuracy "could possibly be expected from such measures."

been taken of the state of the latter, in any of those reports; although the points marked on the gold studs, on both of Bird's Parliamentary standard brass rods, are so large and ill defined, that no two observers are likely to agree as to the precise position of the centers of those points. It may therefore be regretted, that one of those standards should have been adopted as the only legal standard of English lineal measure, in 1824, and dignified by the title of the Imperial Standard, by recommendation of the Royal Commissioners on Weights and Measures, who showed too much diffidence, in not having superseded it by a new one, made under their own direction, with a degree of accuracy and precision suited to the present improved state of the arts. In all the standards or scales of more recent date, made by other artists of any reputation, that I have seen, the lines are clear and fine, and the points small and regular, even when examined by the most powerful microscopes now in use, which magnify the dots of Bird's Parliamentary Standard of 1760, into large unseemly irregular blotches. The defects of this standard struck me forcibly, from having occasionally attended the recent comparison made between it, and the excellent new standard of the Royal Astronomical Society. This comparison, officially conducted with the greatest care, by Lieutenant Murphy of the Royal Engineers,* assisted by other scientific gentlemen, occupied a length of time, that could scarcely have been anticipated; owing partly, I admit, to the difficulty of making such comparisons properly; but in a still greater degree to the uncertainty of that Parliamentary standard, which having no properly defined points to mark the intended length, should be deprived of the legal authority with which it has been invested, and laid up on the same shelf with the still ruder English standards of the sixteenth century.

* Chiefly for the purpose of determining, in imperial measure, the precise length of the great base line measured in Ireland, by means of the ingenious apparatus of invariable metallic rods, on the compensation principle, invented by Lieut.-Colonel Colby, Director of the Trigonometrical Survey. The rods used in this important measurement, in which Lieut. Murphy was one of the Officers employed, were to be compared with the imperial or Parliamentary standard, but owing to the uncertain state of that standard, it was soon found that it would be of little or no use to limit the comparison to it alone. The new standard of the Astronomical Society, as well as Sir George Shuckburgh's celebrated standard, were therefore also examined, as a matter of necessity; and the proportion between the former and the mean length of the imperial standard, for it cannot be said to have any precise length, has been determined by Lieut Murphy with all possible accuracy.